# TRANSACTIONS

OF THE

# Odontological Society of Great Britain.

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VOL. XXXI.—NEW SERIES.

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# ODONTOLOGICAL SOCIETY

OF

# GREAT BRITAIN.

VOL. XXXI.—NEW SERIES.

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# Odontological Society of Great Britain.

## ORDINARY MONTHLY MEETING

*December* 5, 1898.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

THE Minutes of the last Meeting were read and confirmed.

The following were proposed for membership of the Society:—As a non-resident member, JAMES MOUNTFORD, L.D.S.Eng., 24, Bennett's Hill, Birmingham. As resident members, TRAER HARRIS, M.R.C.S., L.S.A., L.D.S.Eng., 112, Harley Street, W.; EDWIN WILLIAM HARWOOD, L.D.S.Eng., 97, Sloane Street, S.W.; MURRAY THOMSON, L.D.S.Edin., 147A, Harley Street, W.

In the absence of the Librarian, the SECRETARY announced that Mr. Storer Bennett had presented to the Society two volumes of the *Clinical Society's Transactions*, vols. xxvii. and xxxi.

The CURATOR (Mr. Storer Bennett) exhibited a partial upper denture presented to the Society by Mr. Bullen, of Chester, an interesting specimen of somewhat primitive workmanship. It was a partial upper gold plate with flat teeth soldered on, made in Naples about 1850. The patient for whom it was made wore the plate with a lining of wash leather for twenty years, and at the end of that period (1870) a new entire upper plate was made which was very satisfactory. It was remarkable (said Mr.

Bennett) that anyone could tolerate in the mouth such a primitive specimen of workmanship, especially when it was made to fit by means of a wash leather sucker. Mr. Bennett said it was a matter of common observation that if a plate once fitted it was often possible to wear it with tolerable comfort long after it presented the slightest resemblance to the mouth in which it was worn, though if a new one were made fitting nearly as badly, it could not be retained for a moment.

## Casual Communications.

Mr. R. H. Woodhouse brought before the notice of the Society a case illustrating the effect of the passive method of regulating teeth. The case was one of a boy, 15 years of age. On account of very rapid decay between the bicuspids and the molars, Mr. Woodhouse was obliged to extract the second bicuspids in the maxilla and mandible before the second permanent molars were fully erupted. Fearing the molars would rapidly move forward, he inserted a splint plate with a view of preventing this, and the result desired was obtained in a very reasonable time and in a very fairly satisfactory way. Another case he showed was that of a little girl, aged 11. The decay was of a very rapid character, and he removed the four second bicuspids and adopted the same form of plate with equally satisfactory results.

Mr. Clayton Woodhouse exhibited models illustrating the method of holding back the second permanent molars. In his case he had removed the first permanent molars in both the maxilla and mandible and had held back the second maxillary molars for about a year with a splint plate. The teeth improved without any other mechanical interference. Models of the case before and after treatment are shown on pages 28 and 29.

Mr. R. H. Woodhouse stated that the second bicuspids were removed in his case on account of their very faulty character. The molars were quite sound on the approximal

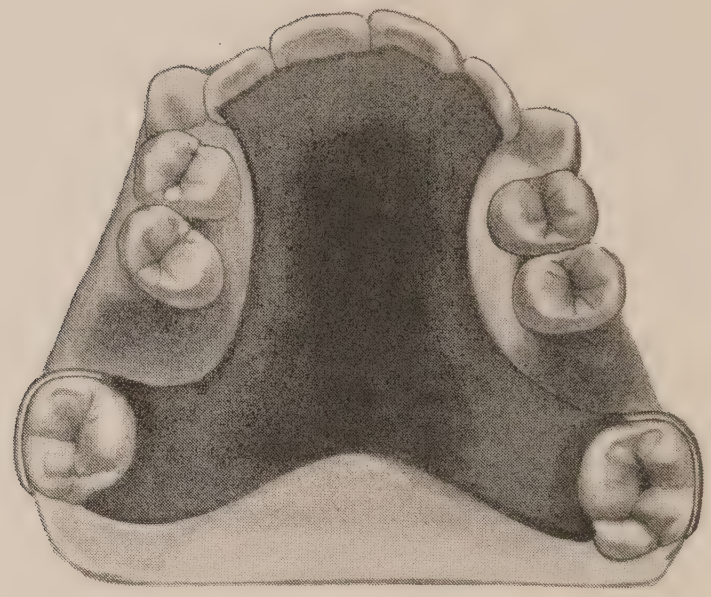
surfaces, between the first and second molars, and therefore he had no choice but to sacrifice the second bicuspids. Of course the same principle applied, perhaps more forcibly, to the removal of the first permanent molars when necessary.

Mr. F. J. Bennett pointed out that the President himself some time ago had advocated the saving of the first molar in preference to the second bicuspid. He (Mr. Bennett) thought it was one of the wisest remarks made before the Society, because, as the President pointed out, the molar could be more easily saved by filling than a bicuspid. The remark of the President was made before the days of crowns and bridges, and it seemed to him, if it were true then it was doubly true now with our increased knowledge of conservative dentistry.

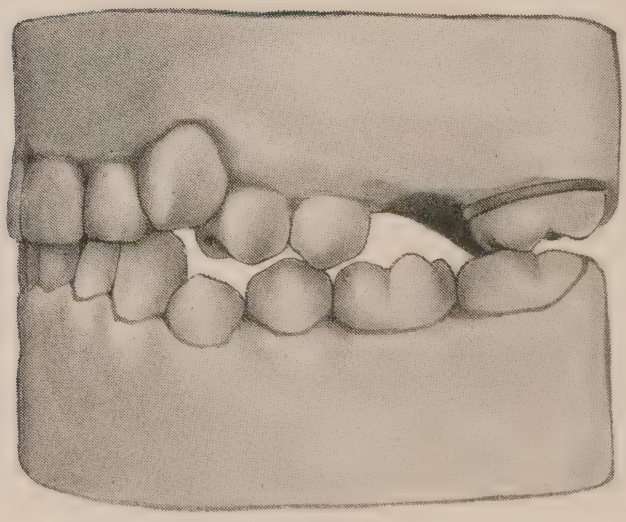
The President thought that the retention of the first permanent molars was perhaps called for in cases where the lower incisor teeth impinged upon the gum behind the upper incisors. In such a case it was very important to keep the bite well open at the back of the mouth. That was not done when the first molars were taken out.

Mr. Storer Bennett pointed out that the canines being very crowded outside the arch, the bicuspids, by the particular form of plate shown, had been allowed to pass backwards of their own accord, and the whole thing had righted itself simply by the very ingenious piece of mechanism which Mr. Alfred Woodhouse originally devised.

Mr. W. A. Hunt showed the model of a mandible of a man aged about 36. Mr. Hunt had extracted all the teeth in May last because they were extremely loose, and the whole of the mandible and soft tissues were in such a state of inflammation that he feared necrosis might supervene. However, although the teeth were loose enough to wobble about, they required a considerable effort to extract them, there being a kind of ligamentous attachment to the soft tissues. They were not in their alveolar sockets at all. The

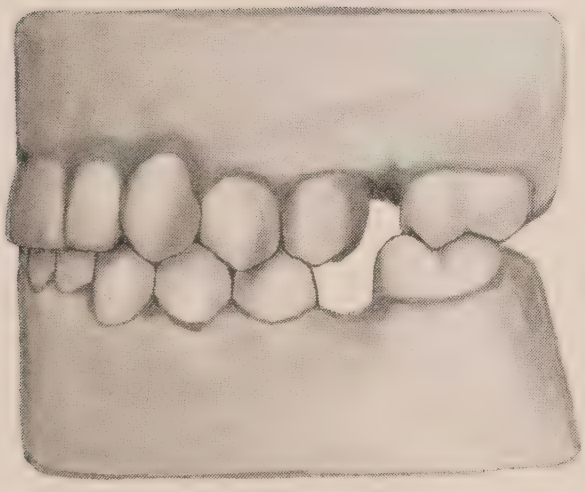


Before Treatment.



Before Treatment.

After Treatment.



After Treatment

patient returned to him a few weeks ago with the mouth marvellously healthy. He had thought that nothing would be more easy than to give the patient a good lower denture, but when he came to look into the mouth he found no surface at all on which to rest the plate. He asked whether any member could give him any practical hint as to what method should be pursued to make the patient a comfortable and useful plate.

The PRESIDENT said a satisfactory result in such a case depended to a great extent on the perseverance of the patient. He had in his mind a patient who always wore his lower plate a quarter or half an inch in front of its proper position, the front portion of the plate resting on the mucous membrane, between the dental ridge and the lip.

Mr. HUNT said he could get a little bit of surface in front, but it was at the sides that he had no foundation to work upon.

Mr. W. E. HARDING remembered some few years ago Mr. Dall, of Glasgow, bringing forward a case in which he had drilled holes on each side of the mandible, into which he inserted pins attached to the plate. He thought, if such a procedure were justifiable, Mr. Hunt's was a very suitable case in which to try it.

Mr. DAVID HEPBURN did not know whether it would be any consolation to Mr. Hunt to know that others sometimes met with cases similar to his, and if he failed he certainly was not the only one. He (Mr. Hepburn) had in his mind a very difficult case where he had every opportunity of trying many devices. He had a most intelligent patient who was interested in the work, and who did her best to overcome the natural difficulties which existed in her mouth. The anatomical conditions were not quite the same as those described by Mr. Hunt, but they were particularly interesting. It was not one of those flat mandibles where what was called a slip had to be contended with when the denture was made, but was one in which the muscles and integuments gained the supreme

mastery over what remained of the alveolar ridge, if anything of it remained. In his case, so strong were the muscles and so thick the integuments that he had to take a model by using a material which required a certain amount of pressure before he could get a fair impression of what remained of the jaw. As soon as any denture was placed in the mouth it was lifted upwards, and floated about in the mouth like a ship in a troubled sea. After many and prolonged trials he gave the case up, and the patient had to be content to go without lower teeth, and had been in that condition for some ten years.

Mr. Reinhardt asked if Mr Hunt had tried first taking an impression in composition, covering more of the mouth than was required for the plate, then, cutting out the inner part of this impression leaving a thick rim all round, afterwards filling the space made with soft plaster and taking another impression, pressing it well down into place; the rim of composition would force the soft tissues away and allow the plaster to take an impression of the part to be covered by the plate without any pressure. He remembered two cases of very flat lowers, practically without any ridges whatever, the patients being unable to keep plates in place, but by using this method of impression taking they were able to wear plates with comfort.

Mr. Humby said he had had a great deal of mechanical work to do in his time, and had had a great deal of difficulty in similar cases to those shown by Mr. Hunt. The model did not show the true state of affairs. It was hardly a correct model to form a proper judgment upon. He took it that the pedestal on which the teeth were placed when the teeth were taken away should really logically follow the teeth and be absorbed, as the presence of the pedestal on which the teeth rested was not necessary for the bearing of the teeth. Hence, in many instances, the alveolar ridge was completely taken away, and a gutter very often remained. In other cases the muscles of the lip and the muscles of the floor of the mouth became, so to speak, united together by a thin cord of gum. He

could not tell from the model whether that was so in Mr. Hunt's case. He (Mr. Humby) had had many cases in which a thin cord of gum represented the alveolar ridge. He was never able to do much with such cases, but recently he had tried a plan and had had a moderate amount of success. He most emphatically disagreed with what Mr. Hunt called the alveolar ridge. The only ridge represented in the model was the inner wall of the groove he had just referred to, and the outer wall was not represented because the model appeared to have been taken short where the outer wall had been. If a good model of the mouth could be obtained, the inner and outer walls of the alveolar process which still remained would be seen. In cases where the elevation of the gum ceased to be above the level of the jaw and became slightly concave, he considered Truman's Gutta Percha should be used. Mr. Reinhardt had brought forward a method of taking a model of the mouth in composition and then substituting plaster, using the outer rim as an impression tray. That was reversing entirely the principle upon which a case like Mr. Hunt's was to be met. There was absolutely no contributory resistance from the soft tissues, and unless the soft tissues were in a condition to contribute resistance to the weight of the denture under the bite, all the pressure of the bite fell upon the row of tubercles round the inner and outer sides of the alveolus, and consequently there was always pain and suffering. A model should be taken with the composition moderately cool, the case made, and the lower portion of the denture cut away to the depth of one-eighth of an inch. Truman's Gutta Percha should then be substituted for the vulcanite, and made to the exact shape of the original model by casting a plaster impression of the set as finished. It should then be allowed to harden, be trimmed up, and finished off with chloroform and other things to make it smooth. It must then be placed in moderately hot water and put into the mouth. The gutta percha does not harden for at least an hour, and all the time the pressure of the bite is directed on the teeth, and the piece is forced down. If Mr. Hunt would proceed in

that way and could get springs to hold the case steady, he thought his patient would have a reasonable chance of possessing a comfortable denture.

Mr. HUNT said he was familiar with the method mentioned by the last speaker, but in his case he did not see how to adopt it. The only thing he could himself see was to dissect away the tissues and keep in a tent, so that they might acquire an attachment lower down. It was rather heroic treatment, but it had been done by several operators in America.

Mr. J. F. COLYER exhibited for Mr. T. Carter, of Leeds, a suture case for use in wiring fractured mandibles.

Mr. COXON showed a case of superior protrusion with the laterals of large size.

Mr. BRUNTON showed a skull of a Maori in which the first permanent molar was impacted on the right side of the mandible. The skull was dug out of some sand hills in New Zealand, evidently an old Maori burial-place.

## *Some Old and New Views of Calcification of the Teeth.*

By F. J. Bennett, M.R.C.S., L.D.S.Eng.

Mr. President and Gentlemen,—It is just forty years since George Rainey published his treatise on "The Mode of Formation of Shells of Animals, of Bone, &c., by Molecular Coalescence," and to about that period belongs the quite independent investigations of Professor Harting, of Utrecht, although it was many years after that his work became known in England.

As most of our ideas of the mode of deposit of lime salts in the teeth have been largely influenced by these researches, I think it but right to briefly describe some of the essential points on which their conclusions were based. A fuller examination must be left for those who choose to enquire into the matter for themselves.

Briefly stated, one may say these observers considered they were able to reproduce artificially certain of the calcareous structures found in the animal kingdom, such as shells, spines,

&c., and according to Rainey, bones and teeth. And further, that the form in which the lime salts were found in these tissues was largely due to the colloid solution in which they were deposited. Their experiments consisted essentially in causing the salts of lime to be formed in the presence of a viscid medium, and of combining with this, whilst in a nascent state. The substances employed by Harting were either calcium chloride, calcium nitrate, or calcium acetate, uniting in the solution with either sodium bicarbonate, sodium phosphate, or ammonium phosphate. The colloid fluid being albumen or gelatine, Rainey's chief experiments were made with gum arabic in solution, which was allowed to mix slowly with another solution of the gum containing potassium carbonate, the calcium which exists in the gum arabic uniting with the carbonate from the potash to form calcium carbonate. After resting for some weeks it was found on microscopical examination that the natural shape of the crystals of carbonate of lime no longer existed, that the form was that of granules or spherites or globules, free or coalescing. Rainey found in the union of these globules an exact resemblance to the youngest layers of the shell of crustaceans and also to the recently formed bone of certain fishes, and concluded that a

similar mode of formation existed, the globules by a mutual fusion forming into laminæ. He further considered the artificial globules explained the nature of interglobular dentine.

So far as these experiments refer to the formation of shells I have nothing to say against the theory, but when it is sought to apply it to a consideration of the teeth and bones, to my mind it is open to some grave objections, the chief of which is revealed by a study of the percentage composition of enamel, dentine and bone.

We find in a hundred parts of enamel—calcium phosphate, 89·82 per cent.; calcium carbonate, 4·38 per cent. In a hundred parts of dentine—calcium phosphate, 66·7 per cent.; calcium carbonate, 3·36 per cent.

Side by side with this analysis let me quote from one of Prof. Harting's experiments.

"When calcium phosphate is liberated by the double decomposition of calcium chloride and neutral sodium phosphate or ammonium phosphate, in a solution of albumen or gelatine, no combination takes place with the organic matter, the precipitate consists entirely of crystals of neutral calcium phosphate. The case is quite different if calcium carbonate is at the same time produced in the liquid. The precipitate then consists of a combination of

the organic matter with the two calcareous salts. If calcium phosphate exists in large quantity, then the precipitate remains even after several weeks in the amorphous or colloid state, neither crystals nor calcospherites are formed, but if on the other hand the calcium phosphate constitutes nothing more than a small fraction of the precipitate, calcospherites are formed, but amongst them are some which are the starting place of various ulterior formations."

These he reduces to two fundamental forms, either plates, or scales or spines.

It is perfectly clear from these remarks that phosphate of lime formed in a colloid in anything approaching the proportions of bone, dentine or enamel would be quite incapable of assuming anything like the form of calcospherites; indeed, Harting strictly limited the term "calcospherite" to carbonate of lime in a colloid medium, or with only a trace of the phosphate, and it was intended by him to apply to shells and the like.

Other forms, as we have seen, are produced by the addition of phosphate, but not the globular or spherite form.

Dr. Ord, whose subsequent experiments much extended our knowledge of the behaviour of lime salts in colloid media, fully bears out Harting's view on this point.

As bearing on this question, the most valuable of Dr. Ord's experiments was that in which he caused the lime salts to be deposited in coagulated albumen in the exact proportions found in bone, at various temperatures, ranging from 70° F.

In all the bone-salt experiments a uniform result appeared at all temperatures. The carbonate was "subduced," as he called it, by the phosphate, and an even, continuous deposit was produced in which no spheres could be seen.

He says again:—"In warmth and cold alike phosphate of lime when used alone was evenly distributed in definite strata, not forming crystals or spheres, but cementing the albumen to great hardness."

In short, we may say Dr. Ord had in these experiments very fairly imitated the deposit such as forms the matrix of dentine or bone.

From a study of their works, it is quite evident that nothing resembling the globules of interglobular dentine were produced by either of the three observers when using substances producing phosphate of lime in any quantity approaching that existing in dentine or enamel; and therefore, if we still cling to the idea that interglobular dentine is allied to Rainey's globules or Harting's calcospherites, we can

only do so on the assumption that this defectively formed area of dentine consists chiefly of carbonate, not phosphate of lime, but there is no direct evidence of this. And Rainey, who was the great advocate of dentine being formed on the globular principle, has to fall back on vague comparisons, such as "the globular particles of carbonate of lime in shell are doubtless analogous to the globular dentine in teeth." And when he comes to deal with phosphates, he seems, for the time at any rate, to realise his difficulty. Thus he says, "Magnesium carbonate does not become globular in gum arabic, and it is this part of the triple phosphate which prevents the globular form;" but in admitting this, it negatives the idea of globules in dentine also.

In fact, his experiments with phosphates do not tell in his favour as an investigator. For instance, he was mistaken in supposing phosphate of lime to be an ingredient of gum arabic, for it is carbonate, not phosphate of lime which the ash of gum arabic yields. So that the globules in the gum were due to carbonate, not to phosphate of lime, as he supposed.

In the other experiment which Rainey records, he added phosphate to the gum arabic, and he says—"If there be an excess of triple phosphate in the gum, the calculi will be studded with

crystals." But we may rightly interpret this by saying the carbonate in the gum arabic formed the globules, and the phosphate remained unaltered as crystal. I think, therefore, Harting with justice remarks "on the too limited number of Rainey's observations."

Nowhere, as far as I know, does direct experiment favour the globular form as a possible arrangement of the lime salts in the teeth.

In certain stages of tooth formation, spherical forms appear which are by no means easy to account for; and by inference only, and that I think a doubtful one, do we connect it with the globules formed by Rainey and Harting, and we do but add to the complexity if our inferences are wrong. In saying this, I admit the weight of opinion which still supports the globular theory, and we must bear in mind there is another aspect to the question which Mr. Tomes lays stress upon. It is this: do we really know the proportion of the salts in bone and teeth? He says: "Great discrepancies exist in the amount of carbonates estimated, and this arises from the great practical difficulty in making a quantitative analysis of small portions of carbonic acid in a substance of which only very small quantities are obtainable, sources of error, which cannot be eliminated, thus creeping in." And he returns to the view of Hoppe Seyler, that the

phosphate and carbonate of lime as it exists in teeth is really a double salt, a combination of three equivalents of calcium phosphate with one of calcium carbonate, analogous to the mineral apatite, in which the fluorine or chlorine of apatite is replaced by the radicle $CO_3$; apatite being $Ca_{10} F_2 (PO_4)_6$; the double salt of phosphate and carbonate of lime being $Ca_{10} CO_3 (PO_4)_6$.

In some such way, either the quantity or the power of the carbonate, so it is assumed by Mr. Tomes, would be increased to that degree as to be capable of yielding the globules even in the presence of phosphates.

Mr. Tomes remarks also "that dentine of many mammals is much more rich in magnesium phosphate than human dentine, and even in the latter it is various in composition;" and, as I have pointed out, it was the magnesium that Rainey found an obstacle in forming globules in phosphate of lime solutions.

As though to celebrate this fourth decade of Rainey's theories, there has lately been almost a "boom" in calcospherites. Mr. Tomes finds in them an explanation of the round bodies in commencing dentine formation. Mr. Leon Williams describes rounded and disc-shaped bodies in forming enamel, and speaks of calcospherites which by melting together produce the larger masses of calcoglobulin. This seems

a confusion of terms, for the latter substance, according to Harting, was the altered form of albumen after the lime salts had been removed.

Dr. Andrews, of America, and Mr. Underwood also find calcospherites in enamel.

But there would still have to be considered the very difficult question as to how it was calcospherites did not more often form in other albuminous constituents of the body, in the salivary glands, in atheromatous patches and in calcifying tuberculous nodules; and in regard to the deposition of the lime salts in whatever pattern, on the principle adopted by Harting or Dr. Ord, we have still a difficulty in assuming that calcium chloride or the like exists free in the blood or tissues, an almost impossible question to settle. But this aspect of the question leads me to dwell for a few moments on the views of Dr. Sims Woodhead as to bone formation, in a paper read before this Society in 1892, and probably fresh in the minds of many here present.

After an examination of the processes in which bone is formed and removed in acute and chronic inflammation, which leads to his views on the normal laying down of the salt, he says :—

"In examining this process of calcification in chronic inflammation, we must always bear in mind that we have a mass of active cellular elements with which the blood and lymph are

constantly coming in contact; the fluids are the carriers from which the cells obtain their nutrient material; they are the vehicles by which effete matter is removed, and, as a matter of fact, it has been found that in the neighbourhood of all active cells these fluids differ very markedly in their composition from the general fluids. For example, there is always an increase in the amount of free carbonic acid in the fluid near these cells, and we have a formation of phosphate and carbonate of lime, the latter in comparatively small amount. In the neighbourhood of dead membranes, if these salts are removed at once by dialysis, they remain stable, and may be deposited at once; but if they are allowed to remain in contact with the phosphoric acid of the blood and the alkaline phosphates, they are redissolved and are again returned to the fluid circulation. As Irvine and I have pointed out elsewhere, this primarily bears on the process of calcification of bone. The osteoblasts lay down a matrix of formed material; the more active the cells within certain limits, the greater the relative amount of matrix. This matrix may be looked upon as inert or dead organic matter, "which corresponds to a membrane through which dialysis may take place, or rather the layers near the two surfaces may be so considered; and as the molecular combinations of the

phosphoric acid and lime, and the carbonic acid and lime take place around the osteoblasts (which, as above stated, during their active formative changes give off the carbonic acid to render the lime for the time insoluble), there is a continuous process by dialysis of separation of these lime salts, which first make their appearance in the centre of the matrix trabeculæ where the two currents meet, as it were; from this point the calcification extends towards the surface. We look upon the formed matrix, then (or dead material), as playing the part of a dialysing membrane that serves to separate the lime salts prepared in its immediate neighbourhood by the carbonic acid forming cells, this carbonic acid causing a throwing down of phosphate of lime, with a small proportion of lime in which the phosphoric acid is usually replaced by carbonic acid. It should be observed in this connection that the carbonic acid is, when acting on the lime solution, in a nascent condition; therefore in a much better position to combine with any lime already held by the phosphoric acid."

In this explanation of Dr. Woodhead's it may be that the salts after filtration through the dead membrane are merely deposited in the fibrous basis simply as granular particles in no chemical relation with this basis whatever. In like manner it may be so in the dentine, and Pro-

fessor Harting's union of lime salts with albumen in calcoglobulin may have nothing to do with bone or dentine, and this notwithstanding that we are aware of a tough indestructible form resembling it on the border line of dentine calcification. But in reflecting on the powerful influence of carbonic acid in determining calcification, its effect would appear to be something more than merely holding the salts in solution and throwing them down on its removal. It has occurred to my mind whether, after all, the curious union and molecular form of carbonate of lime that Harting found in albumen may not be due to some action of free carbonic acid evolved in the colloid solutions causing a more intimate blending and modification of both organic and inorganic constituents.

But the extremely physiological aspect of Dr. Woodhead's theory is one we should all bear in mind, and the state of activity of the cell, the function of the osteoblast, and peculiar properties of imperfectly nourished membranes, &c., &c. For we have to learn not only how the lime salts are deposited, but how they are prevented from depositing in other parts. For instance, what controls those depositing in the cells of the salivary gland? Does the carbonic acid hold this in check?

It seems to me, also, Dr. Woodhead's views

suggest the clearer understanding of a possible cause of calcified structures in the ovary and other meaningless situations. Forms of degeneration, such as cysts, are common in the ovary, and it is possible that occasionally the degeneration may assume another form, that of the dead membrane with its affinity for lime-salt precipitation.

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Dr. Woodhead, TRANSACTIONS OF ODONTOLOGICAL SOCIETY, 1892.

Tomes' "Dental Anatomy," 5th edition.

## Discussion.

Mr. H. Lloyd Williams said the question which seemed to him extraordinary was that the basic substances of enamel and dentine respectively seemed totally different from each other. He asked Mr. Bennett whether carbonic acid had any influence in the matter. Apparently it did not greatly differ originally, because physiologically it could not be understood that there was any great difference between an odontoblast and an animal cell; yet the basic substance of enamel seemed to materially differ from that of dentine.

Mr. Storer Bennett said most of the teaching of physiology was altered once in seven years, and what was recognised as being absolutely true to-day would be demonstrated by a set of observers seven years later to be absolutely false. And so it was, apparently, with many of the teachings a few years ago held to be perfectly accurate. When he was a student it was recognised—and he did not think anyone questioned it for a moment—that the formation of the calcification of dentine took place by calcospheroids being deposited, the calcospheroids running together and becoming fused into a solid substance, and forming the matrix between the dentinal fibrils. It was curious that such a belief appeared to have been jumped at by physiologists without any attempt being made on the part of any dental physiologist to verify the statement. As far as he knew, there was no original observation made by anybody to the effect that he had seen such a proceeding taking place. Mr. Tomes, in his lectures years ago, and in his book, said that the recognised view was so and so, but he did not say that he had seen it, and he did not quote anybody else who had. A

statement having crept into a book, was copied from one edition to another, and from one book to another, without the least attempt being made by anybody to verify the original statement. It so happened that he had the opportunity not long ago of urging that the younger practitioners should themselves undertake original investigation. He thought they would be very fruitful of results and prove valuable sources of information, and the members of the profession might be greatly benefited by some attempt either to verify or disprove the statements which were found in the ordinary text-books. The question as to whether those calcospheroids did or did not enter into the formation of dentine, or as to how dentine itself was formed, would be a very interesting field of investigation, one which would reward all the trouble which might be taken by anybody who went into the matter.

Mr. Ashley Barrett asked Mr. Bennett if he could throw any light on what seemed to him an obscure and difficult thing to comprehend. Why should the layer of dentine first calcified assume its special aspect, showing globular spaces with convex boundaries? They knew that it was so, but what cause could be assigned for the condition?

The President asked Mr. Bennett what his opinion was as to the function of the cell and the importance of the action of the cell in cases of calcification. He presumed there was a special cell that was engaged in the production of dentine and also a special cell engaged in the calcification of enamel. He questioned whether there were any cells connected with the calcification which occurred in the structure of the pulp as met with.

Mr. Brunton said the question was not one with which he was familiar, but it occurred to him that probably a little light might be thrown upon the deposition of lime by observing the fresh-water snail. If the body of a fresh-water snail were taken out of its shell and dropped into water, in a few hours it would be found that the fresh-water snail built itself a new house.

Mr. F. J. Bennett, in reply, considered that his paper

had rather fallen on unfortunate times so far as discussion was concerned. He trusted that the members would do him the favour of reading the paper, and in that way try and interest themselves in the question, and he asked the junior members especially to at least read a few of the treatises on the subject, and possibly a spark of enquiry might be ignited which would burn into the flame of investigation. The functions of the cells, of course, might be considered from two points of view. They might have a function like the odontoblast or the ameloblast or the osteoblast, of forming the matrix. He did not see, if there was phosphate of lime and carbonate of lime thrown down in the enamel or the dentine, whether it mattered if the enamel was derived from an epithelial structure or the dentine from a connective tissue structure. The animal basis would be different, no doubt, but so far as the animal basis was concerned they were both colloid, and therefore, according to Harting and Rainey, they would both equally serve the purpose of receiving the lime salts and modifying their form. There was special action of the formative cell which Dr. Woodhead dwelt upon, and that was the somewhat new idea that it was a carrier of carbonic acid. It had been known for a long while that carbonic acid held in solution the phosphates of lime, and by passing off the lime salts were precipitated. It was known that saliva contained carbonate and phosphate of lime, which was passed into the mouth in a soluble form, but as soon as the carbonic acid passed off they were precipitated in the form of tartar on the teeth. Dr. Woodhead suggested that the action of carbonic acid in the blood was far more complex; it was continually holding and letting go the phosphate of lime. But its especial function of holding the carbonic acid in the bone-forming cell was to hold command over the lime salts, either to make them soluble or the reverse. Mr. Ashley Barrett had spoken of the margin of early formed dentine. He was not quite sure whether he understood him to mean the convexities which were found at the very margin of the dentine. That had been explained by some as representing the little points where the enamel

prisms fixed against the dentine, but that was not a very adequate explanation. He did not get the gist of his remark about the granular layer, but of course the granular layer was supposed to be a mere form of interglobular dentine. The majority of people imagined that interglobular dentine was a relic of Rainey's globules, owing to an arrest in the finishing of the structure. The point he wished to bring out in his paper was that although they were very eager to find out what interglobular dentine was, because it was unquestionably the key to the structure of dentine, they were not obliged to take Rainey's theory. They might still look about for another theory, but if they thought it was due to calcospherites there was the great difficulty that nobody had ever been able to make a calcospherite out of a composition like dentine and bone, and that it was only a product which could be produced by carbonate of lime—not phosphate of lime. Mr. Brunton had alluded to the fresh-water snail and its new mantle secreting very rapidly. It was known that the lobster and other crustaceans very rapidly produced their form of shell. He did not dispute that Rainey was wrong with regard to gastropods, because it was known that the shell was formed of carbonate of lime. Artificial calcospherites could be formed in carbonate of lime. The difficulty occurred where phosphate of lime had to be dealt with.

The thanks of the Society having been accorded to Mr. Bennett and the various speakers of the evening, the Society adjourned to Monday, January 9.

# Odontological Society of Great Britain.

## ORDINARY MONTHLY MEETING,

*January* 9, 1899.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

THE Minutes of the previous meeting were read and confirmed.

Mr. W. MAY signed the Obligation Book and was admitted a member of the Society.

The following gentlemen were balloted for and elected non-resident members of the Society :—Mr. GUY CHATTERTON, L.D.S.Eng. ; Mr. HENRY REGINALD FRYER BROOKS, L.D.S.Ed. ; Mr. HERBERT MEER, L.D.S.Eng.

The following were proposed for membership of the Society :—As resident members: Mr. ROBERT H. MANNING, L.D.S.Eng.; Mr. CARPENTER HARRIS, L.D.S.Eng., M.R.C.S.; Mr. WALTER FLOYD, L.D.S.Eng. As non-resident members: Mr. JOHN HARPER, L.D.S.Eng., L.R.C.P., of Cape Town ; and Mr. A. L. GOADBY, L.D.S.Eng., of Reading.

The TREASURER presented the balance sheet for the year ending October 31, 1898.

The LIBRARIAN reported the receipt, in addition to the usual exchanges and periodicals, of *The Transactions of the New York Odontological Society*, the first volume of *The Transactions of the Society of Anæsthetists* for 1898, and also an antique print of Guy's Hospital for Incurables, presented by the Hospital authorities.

# The Accounts of the Odontological Society for the Year Ended October 31st, 1898.

*Cash Account.*

| Dr. | | | | | | |
|---|---|---|---|---|---|---|
| | | £ | s. | d. | £ | s. d. |
| To Balance at Bank, as at November 1st, 1897 .. .. . | | 5 | 12 | 2 | | |
| ,, ,, in hand, as at November 1st, 1897 .. .. .. | | 18 | 18 | 0 | | |
| ,, ,, Petty Cash, as at November 1st, 1897 .. .. | | 2 | 2 | 2 | | |
| | | | | | 26 | 12 4 |
| ,, Annual Subscriptions for current year and in advance .. | | 475 | 13 | 0 | | |
| ,, ,, ,, Arrears .. .. .. .. .. | | 68 | 5 | 0 | | |
| | | | | | 543 | 18 0 |
| ,, Entrance Fees .. .. .. .. .. .. .. .. | | | | | 24 | 3 0 |
| ,, Sale of Transactions .. .. .. .. .. .. .. | | | | | 4 | 5 2 |
| ,, Interest on Investments .. .. .. .. .. .. | | | | | 121 | 11 5 |
| | | | | | £720 | 9 11 |

| Cr. | | | | | | |
|---|---|---|---|---|---|---|
| | | £ | s. | d. | £ | s. d. |
| By Rent, 1 year .. .. .. .. .. .. .. .. | | | | | 150 | 0 0 |
| ,, Fire Insurance, 1 year .. .. .. .. .. .. | | | | | 3 | 7 3 |
| ,, Meetings. | Baker—Hire of Microscopes, &c. .. .. | 4 | 2 | 6 | | |
| | Reed & Sons—Reporting .. .. .. | 16 | 16 | 0 | | |
| | Camps—Refreshments .. .. .. .. | 16 | 2 | 6 | | |
| | Postages .. .. .. .. .. .. | 23 | 12 | 8 | | |
| | | | | | 60 | 13 8 |
| ,, Library. | Periodicals .. .. .. .. .. | 4 | 17 | 10 | | |
| | Thomas—Sub-Librarian .. .. .. | 11 | 5 | 4 | | |
| | Thomas—Binding .. .. .. .. | 4 | 10 | 6 | | |
| | | | | | 20 | 13 8 |
| ,, Museum. | Ebbs—Attendance .. .. .. .. | 16 | 1 | 0 | | |
| | Specimens—Cosmos .. .. .. .. | 2 | 18 | 0 | | |
| | Curator's Petty Cash Disbursements .. | 5 | 4 | 0 | | |
| | | | | | 24 | 3 0 |
| ,, Transactions. | Bale & Sons—Printing .. .. .. | 111 | 4 | 7 | | |
| | Grevers—Collotype Prints .. .. .. | 9 | 7 | 6 | | |
| | Photos, Blocks, &c. .. .. .. .. | 2 | 12 | 6 | | |
| | | | | | 123 | 4 7 |
| ,, Sundries. | Bale & Sons—Printing Notices, Stationery, &c. .. .. .. .. .. .. | 18 | 16 | 4 | | |
| | Bank Charges .. .. .. .. .. | 0 | 4 | 3 | | |
| | Camps—Honorarium .. .. .. .. | 10 | 10 | 0 | | |
| | Butcher, J. W. & Co.—Accountants .. | 3 | 3 | 0 | | |
| | Broker's Charges on Investments .. .. | 0 | 13 | 6 | | |
| | Cleaning Clock, Electric Light Repairs and Writing Name on Door of Meeting Room | 1 | 2 | 10 | | |
| | | | | | 34 | 9 11 |
| | | | | | 416 | 12 1 |
| ,, Purchase of Consols .. .. .. .. .. .. .. | | 121 | 1 | 5 | | |
| ,, ,, ,, .. .. .. .. .. .. .. | | 111 | 5 | 0 | | |
| | | | | | 232 | 6 5 |
| ,, Balance at Bank, October 31st, 1898 .. .. .. .. | | 59 | 15 | 11 | | |
| ,, ,, with Treasurer .. .. .. .. .. | | 7 | 7 | 0 | | |
| ,, ,, (Petty Cash) .. .. .. .. .. .. | | 4 | 8 | 6 | | |
| | | | | | 71 | 11 5 |
| | | | | | £720 | 9 11 |

## Odontological Society's Accounts for 1897-98—*continued.*

*Income and Expenditure Account.*

| Dr. | £ | s. | d. | Cr. | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| To Expenses as per Cash account above | 416 | 12 | 1 | By Subscriptions as per Cash account above | 543 | 18 | 0 |
| ,, Balance, Surplus on the year | 277 | 5 | 6 | ,, Entrance Fees ,, ,, ,, ,, | 24 | 3 | 0 |
| | | | | ,, Sale of Transactions ,, ,, ,, | 4 | 5 | 2 |
| | | | | ,, Interest on Investments ,, ,, | 121 | 11 | 5 |
| | £693 | 17 | 7 | | £693 | 17 | 7 |

## Balance Sheet, November 1st, 1898.

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| To Accumulated Funds, as at November 1st, 1897 | 4,458 | 17 | 5 | By $2\frac{3}{4}$ % Consols, value £4,691 19*s.* 2*d.* bought for | 4,664 | 11 | 6 |
| ,, Surplus on year brought down | 277 | 5 | 6 | ,, Cash at Bank and in hand as above | 71 | 11 | 5 |
| | £4,736 | 2 | 11 | | £4,736 | 2 | 11 |

We have written up the above accounts from the books and receipts of the Odontological Society, and certify the same to be correct. We have seen the vouchers for the amount invested.

J. W. BUTCHER & Co., *Chartered Accountants,*
Imperial Buildings, Ludgate Circus, E.C.

*January 5th*, 1899.

F. CANTON,
DAVID HEPBURN.

*January 6th*, 1899.

The Curator (Mr. Storer Bennett) said the Society had again to thank Mr. Morton Smale for a very valuable contribution to the collection of comparative dental pathology which the museum now possessed. Mr. Smale had sent eight specimens, half-a-dozen only of which he (Mr. Storer Bennett) proposed to present that evening, as two of them would take rather a long description. The first was a specimen of a small monkey's skull (*Circopithecus*), showing the transitional dentition, from the temporary to the permanent. It was interesting, also, as showing an alveolar abscess in connection with the left mandibular temporary canine. The second specimen was also a monkey's skull (*Cynopithecus*), and showed the transition from the first to the second dentition, and was interesting from that fact. The third was the skull of a kangaroo (*Macropus*), in which there was an unusual condition. There had been very considerable periostitis in connection with the right half of the mandible, but apparently quite unconnected with the teeth. The periostitis had caused the formation of a considerable amount of new bone on the surface of the mandible, on the right side, making it at first sight look like a reunited fracture. Another specimen, that of an agouti (*Dasyprocta*), showed the loss of several of the maxillary molars and premolars, and two of the mandibular molars, from absorption of the alveolus. In the front of the molar region the loss of the alveolus was very considerable, the amount of absorption being very great; and the teeth that remained were more or less carious. The incisor teeth, however, were quite unaffected. The next specimen was that of a howler (*Mycetes*), one of the monkeys of the New World, in which the skull had been considerably injured, probably either from a fall or a fight, at any rate the premaxillary bones had been very much smashed. All the upper incisors had been lost, and the suture had been deflected over towards the left side. The result was that the right maxillary and mandibular canines had not worn each other, and the right maxillary canine was separated a good distance from the mandibular one. It was an interesting specimen also as showing a small

alveolar abscess on the right side. It was also valuable because the collection of New World monkeys in the museum was a small one. The last specimen was that of a young lion, showing a large amount of thickening of the bone, as the result of rickets. He (Mr. Storer Bennett) had placed on the table a normal specimen of a lion's skull from the museum for comparison, and it would be found that the skull presented by Mr. Smale was much heavier than the normal one. It would be seen how difficult it must be for a tooth to erupt through such a large amount of dense bone. Hence the delay in eruption commonly found in children who had suffered from rickets was easily understood when the condition of such a skull as this was taken into account.

Mr. Redman presented a left maxilla, showing an impacted third molar erupting horizontally with its crown pointing backwards towards the tuberosity, and its roots appearing through the floor of the antrum.

## Casual Communications.

Mr. Badcock said that in September last a gentleman came to him, a well-built man of about 60, complaining of dull, ill-defined pain in the right maxilla, which had lasted for two or three weeks. It could hardly be called pain, as it did not amount to much more than discomfort, and the patient attributed it to the second molar. On examining the mouth, he found a cavity existing on the mesial side of the third molar, above the cervical edge of an old filling; the cavity extended to the pulp cavity, which was septic. As the third molar was quite useless, having no opponent, he extracted it. For a man of the patient's age it was particularly firm, but its extraction was an easy one in every respect. After extraction he was surprised to find that water passed out through the patient's nose. He advised him to use boracic acid lotion, and to come back if he had any further trouble. As he did not see him again, he concluded that

all went well. As it was the first case he had seen of a third molar communicating with the antrum, he looked the subject up, and so far he had not been able to find any other case specifically recorded. Mr. Tomes, in his "Dental Surgery," said that the canine, bicuspids, and first and second molars were most generally the teeth related to the floor of the antrum, and then went on to mention cases where the central and the lateral had been connected with the antrum, but Mr. Tomes did not, as far as he remembered, say anything whatever about the third molar. Other writers said that the molars might be in relation to the antrum, but they none of them specifically mentioned the third molar. He had found no case mentioned, nor had he seen one, unless a case Mr. Redman had shown him that evening might be considered such a one. He therefore thought it worth while to put the case on record and obtain the experience of other members upon it. Mr. Storer Bennett had kindly put on the table a collection of antra, and it would be seen that generally the antrum extended well back beyond the root of the third molar, and generally over the tuberosity, and in those cases where specimens had been presented of broken tuberosities, in every case it would be found that a part of the floor of the antrum was upon the tuberosity. In his case certainly no part of the floor of the antrum came away with the tooth, and the root, which was roughly conical, presented a periosteum much thickened and inflamed.

Mr. Redman said that some little time ago he had a case of antral trouble, which he attributed to the third molar. He extracted the tooth, but could find no communication with the antrum. He then hunted up all the bones he could, and all the authorities, but found no trace in any of the authorities, and no bones in which the root of the third molar had penetrated into the antrum. More recently in looking through a few more bones, he came across the specimen he had presented that night to the Society.

Mr. F. J. Bennett asked Mr. Badcock whether there was any real direct evidence that the root did go into the antrum. There was a communication with the antrum, but consider-

ing that the periosteum was much thickened, it was quite possible that the opening into the antrum was the result of pathological changes.

Mr. Badcock thought Mr. F. J. Bennett's explanation was probably the right one.

Mr. Baldwin said he was glad Mr. Badcock had drawn attention to the very close proximity of the roots of the third molar to the antrum. Some time ago Mr. Robbins presented to the Society a specimen of the maxillary tuberosity which had come away in an attempt to extract the third molar. At that time he (Mr. Baldwin) pointed out to the Society that between the roots of the third molar there was distinctly a very deep hollow, which had formed part of the floor of the antrum. The roots were in exceedingly close relation to the antrum in that case. In the discussion at the time, he remembered mentioning that the bone was so extremely thin around the roots, or rather over the roots, that it seemed to have been an impossibility to have extracted the tooth without bringing away the tuberosity, as the alveolar process would stick to the roots very much more tightly than the tuberosity would stick to the rest of the maxilla. On looking at several other cases of tuberosities which had been extracted along with wisdom teeth, he found exactly the same condition existing; there was a smooth rounded depression, coming into extremely close relation with the tooth, which was evidently the floor of the antrum. He was glad to have this opportunity of speaking, because in the report of Mr. Robbins' case he (Mr. Baldwin) was stated to have said that if the tuberosity had been replaced in the jaw it would have grown again, which was an evident absurdity.

Mr. Tomes said one point of interest occurred to him in connection with the case, and that was with regard to the growth of the antrum. As everybody knew, the antrum was an excavated cavity which at first did not exist, and afterwards was hollowed out. The fact to which Mr. Badcock had called attention, that the antrum extended right back and over the roots of the third molar, showed

the antrum was enlarging up to a later period than one was in the habit of imagining.

Mr. Baldwin exhibited some instruments of his own design. The first was a set of four small knives, with blades set at an angle transversely to the handle, intended as "filling trimmers." In a number of cases, especially when examining a number of old fillings, it was sometimes found that the gum had receded and exposed a portion of, say, an interstitial tin and gold filling, which was originally under the gum and had been badly finished. It was rather difficult occasionally to trim away that excess neatly with the ordinary knives. Again, it was frequently found that gutta-percha fillings, which were really doing extremely well in interstitial cavities, and presenting a good contour to the masticating surface, were bulged, and it was desirable to trim off the excess of filling and allow the gutta-percha to take a new lease of life. With the knives he exhibited it was possible to trim around the contour, using a mirror if necessary, without leaving a number of facets such as the ordinary knife would leave.

The other exhibit was a new kind of excavator. He was casting about for the means of cutting away softened dentine, causing as little pressure as possible, the idea being that if the dentine could be readily entered by some instrument and elevated, it would be possible to lift the covering of an exposed pulp without pressure. The excavators were serrated, the serrations being suggested by the serrated burs now so much used, and could be made very sharp and kept sharp by rubbing the back of the instrument on the oil stone in the ordinary way. In practice he found them work extremely well. They removed softened dentine more quickly than any other kind of hand excavator, and they could be used either by a direct straight sweep, or by an oblique sweep. If they were used in a direction opposite to their obvious direction, they acted as a saw, a very powerful means of cutting a way through anything. They, moreover, left the dentine with a finely-grooved surface specially adapted for the retention of any kind of filling. The instruments were made by Messrs. Ash. A dental

instrument maker with whom he was acquainted always preferred to leave the flat side of the spoon excavator with the original filed surface, and recommended sharpening on the round side. The edge was thus slightly serrated all round, and gave a very much better cutting tool than an absolutely plain edge.

Mr. H. Lloyd Williams said that he had never found knives very successful for trimming tin, gold and other fillings. He had had various shapes made for him at different times, but he found that a very thin file did the work much better.

Mr. H. Lloyd Williams then exhibited a small modification of Hammond's splint, which he had used for some years for the treatment of fractures of the mandible far back where only one tooth, usually the third molar, remained in the smaller fragment. When the model had been divided at the seat of fracture and put together according to the normal occlusion, a Hammond splint was made in the ordinary way, except that it was made to fit loosely round the tooth in the small fragment. The splint was tinned, the single tooth well greased, and the splint adjusted on the model. Wax was then melted on the splint and tooth in sufficient quantity, and the whole was removed, flasked and vulcanised. Thus a vulcanite cap was obtained which fitted the tooth exactly. The top of the cap was filed off, so that the cusp could articulate correctly with the opposing tooth. Adjusting it in the mouth, the splint was wired in the ordinary way to the large fragment, whose weight drew down the smaller fragment and always kept it in apposition. He had treated seven cases in this manner, six successfully. He would briefly refer to the failure, and to the second case, which was his first success; the others presented nothing of special interest. All the cases were treated at the West London Hospital.

Case I.—M. F., a tall, well-made bargeman, possessing a full complement of teeth, all apparently healthy, was seen in August, 1890. The fracture was between the second and third molars on the right; the smaller fragment was held in the position of closure of the jaws, while the

larger was displaced badly downwards. A piece of tin was struck to fit over the wisdom tooth, and soldered to a Hammond splint. The splint was shown. It was worn for six weeks; a fibrous union resulted. The cause of non-union was the second molar, in which there was a large distal cavity with a septic pulp.

Case II.—L. B., aged 24. Married woman, five months pregnant, came to the hospital in December, 1894. Fracture on left side in front of third molar. Second-molar roots were removed under an anæsthetic, and a splint such as he had described was adjusted. There was perfect union in five weeks. A feature common to every case that had come under his notice deserved to be specially mentioned, as the success of the treatment depended upon its recognition. In every case the second molar was very badly decayed, or was only represented by roots. As it was so extremely difficult in such cases to discover even a large distal cavity in the second molar before the splint was adjusted, and as in all his cases the second molar had had some serious lesion, he should always extract the second molar as soon as the model had been taken.

Mr. H. G. Read said that some ten years ago he had a fractured mandible which presented some points of interest, although not quite parallel with the cases of Mr. Lloyd Williams. A man was kicked by a horse, and sustained a horizontal fracture between the alveolus supporting the six lower front teeth and the basalar portion of the mandible. The molars and bicuspids had been previously lost. He (Mr. H. G. Read) made a vulcanite splint, passing behind the incisors and resting on the gums in the molar region and having a wire passing in front of the teeth attached to the plate at both ends. He then cut away the vulcanite and put a little gutta-percha at the back of the front teeth, and so made a very satisfactory splint. The patient made a good recovery, and sent his wife to say that he found the splint very useful for mastication, and that he would return it later on; but it was not returned, and he lost sight of the case altogether until a few weeks ago, when in putting a Hammond splint on a hospital patient he

happened to mention the case to a student. The man in the next chair said: "Did you do that? because that man works in the same yard as I do, and he is still wearing the case."

## *On the Teeth of Echeneis.*

By J. Howard Mummery, M.R.C.S.Eng., L.D.S.Eng.

The echeneis, or sucking fish, belongs to the Scomberidæ or mackerel family, and has been popularly known from ancient times, the remarkable sucking disc on the back of the head, and the curious habits of the animal having given rise to many most extravagant statements as to its wonderful powers.

In the Annals and Magazines of Natural History for May, 1860, there is an interesting paper by Dr. Günther, on "The History of Echeneis," in which he gives a summary of the statements made by the ancients with reference to this fish. He says, "the opinion that this fish had the power of arresting vessels in their course was a general belief in the first century B.C.," the first mention of it being by Ovid ("Halieut," v. 99).

"Parva echeneis adest, mirum, mora puppibus ingens."

Aristotle, Pliny, Oppian and Œlian, also refer to it; Oppian especially endorsing the popular notions as to its supernatural powers:—

"The sucking fish beneath, with secret chains,
Clung to the keel—the swiftest ship detains.
But though the canvass bellies with the blast
And boisterous winds bow down the cracking mast,
The bark stands firmly rooted on the sea
And will unmoved, nor winds nor waves obey."[1]

The fish is doubtless frequently found attached to the keels of vessels as well as to sharks and other large fish, and an instance is recorded of one found attached to a codfish on our own coasts.

Notwithstanding the fabulous nature of the early stories about the echeneis, as Dr. Günther says ("Study of Fishes," p. 461), "it cannot be denied that the attachment of one of the larger species may retard the progress of a sailing vessel, especially when, as is sometimes the case, several individuals accompany the same ship."

In the paper before referred to, Dr. Günther describes ten species of echeneis, but the most common are the Echeneis remora, found in the Mediterranean and elsewhere, and seldom attaining to a size of more than a few inches, and the Echeneis naucrates, a longer and more slender fish, frequently attaining the length of three feet.

The curious sucking disc which gives the popular name to this fish is a modification of the

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[1] Quoted by Couch, "Fishes of the British Islands."

dorsal fin. To again quote Dr. Günther: "The spines of the dorsal fin, being composed of two halves, each half is bent down towards the right and the left, forming a support to a double series of transverse lamellæ, rough on their edges, the whole disc being of an oval shape and surrounded by a membranous fringe. Each pair of lamellæ is formed out of one spine, which, as usual, is supported at the base by an interneural spine. By means of this disc the sucking fishes are enabled to attach themselves to any flat surface, a series of vacuums being created by the erection of the usually recumbent lamellæ" (Gunther, "Study of Fishes").

Bennett, in his narrative of a whaling voyage, says, "the use it makes of its sucker is much less than may be supposed; it often merely swims around the body it attends, and only fixes upon it occasionally, and for a very short time. The late Professor Moseley, who had several opportunities of observing this fish during the voyage of the *Challenger*, noticed that the sucking fish sometimes dropped off the shark as it was hauled on board, and sometimes remained attached, and that when a shark is hooked and struggling in the water, they may often be seen to shift their position. The same observer also draws attention to the colouring of the fish, the belly being dark and the back light in colour, which is the

reverse of what is usually found in fish; he looks upon this as a protective colouration, the dark colour of the belly of the fish rendering it less conspicuous on the brown back of the shark.[1]

This arrangement of the colouring would seem to indicate that the usual position of the fish would be upon the body of the host, as when freely swimming the protective colouration would not be of any avail.

During a voyage to Australia on a sailing ship in 1871, whilst almost becalmed in the tropical Atlantic, I hooked a shark from the stern of the vessel which had been noticed all the morning swimming round the ship accompanied by several of the elegant banded pilot fish, Naucrates ductor. The shark was about six feet long, and when hooked gave great play, lashing the water into foam around it. The skilful use of a bowline by one of the crew soon secured the animal, and when hauled on deck he was treated with the scant mercy usually shown by sailors to the shark, being dragged along the poop and allowed to fall on to the main deck below, where he was immediately cut to pieces. Any one who has seen a shark lashing about with his tail when first brought on deck, will understand the violent disturbance to which any animal attached to its

[1] "Royal Natural History," Lydekker, vol. v., p. 373.

surface would be subjected, but I found two specimens of the echeneis firmly attached to the skin of the belly by their suckers. No force applied in a backward direction was capable of shifting their position in the slightest degree, but they were easily removed on being pushed gently forwards. These two fish were immediately placed in spirits, and on my return to England were put aside and not looked at for many years.

On examining the specimens (Plate I., fig. 1) which appear to belong to the species, E. Squalipeta (of Daldorf), having seventeen to eighteen laminæ in the sucker and the dorsal and anal fins continued to the caudal, it is noticeable that the lower jaw projects far beyond the upper, so much so, that on closure of the mouth the anterior upper row of teeth shut almost entirely behind the whole of the teeth on the dentary bone in the lower jaw.

This upper row of teeth occupies the anterior border of the intermaxillary bones, projecting almost horizontally forwards, the teeth are also much longer than elsewhere in the mouth, and of a very different shape (Plate II. and Plate I., fig. 2). They are flattened antero-posteriorly, slightly expanded at the base, narrowing upwards and expanding again into a curious spatula- or hoe-shaped crown, strongly recurved and


Fig. 1.

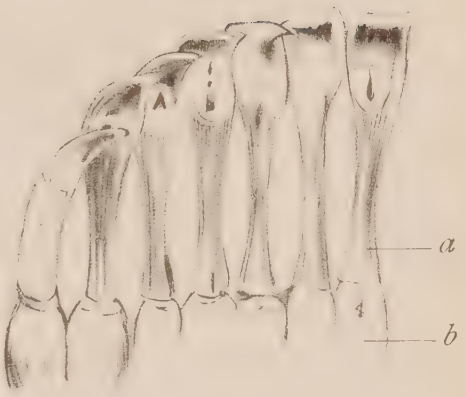


Fig. 2.

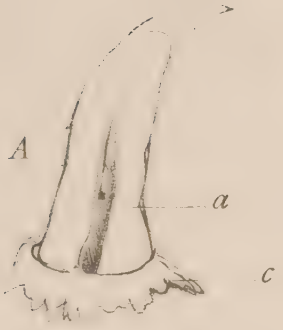



Fig. 4.

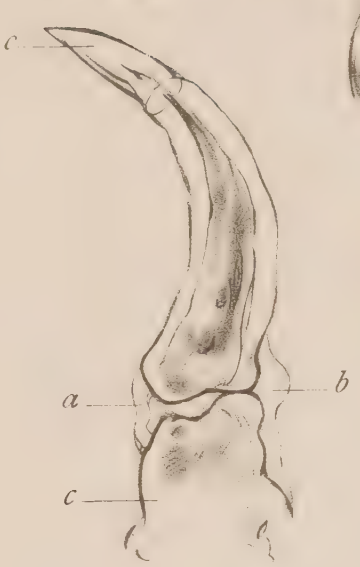


Fig. 3.

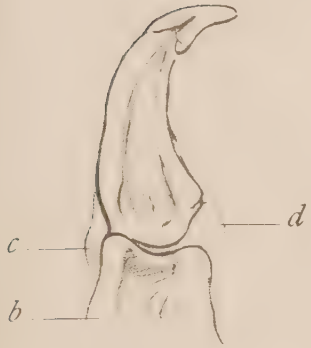


Fig. 5.

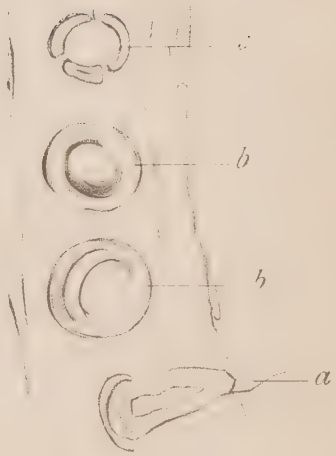


Fig. 6.

Fig. 7.

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prolonged on the mesial side into a point. The crowns are in close contact with one another at their edges, slightly overlapping, and forming a semi-circular line from the angle of the mouth on one side to that on the other (Plate II., *a*), with the exception of a slight interruption in the middle line where four or more teeth are stunted and do not show the expanded crown.

The crowns of these teeth are seen as a glistening line extending beyond the margin of the upper lip.

Behind the angle of the mouth there is a broken line of seven or eight teeth prolonged to the extremity of the intermaxillary bone (Plate II., *c*). These scattered teeth are of a quite distinct shape from those above described, and resemble those in all the other parts of the mouth. Their shape is conical and they are very sharply recurved, with sharp pointed enamel tips.

Behind the spatula-shaped teeth there is an imperfect scattered row of conical incurved teeth on the intermaxillary bones. The vomer (Plate II., *b*) is thickly beset with teeth of the same description, very minute, with the exception of ten to twelve larger teeth on the anterior and outer margins of the bone on each side, which are arranged in two curved rows. There are no teeth upon the palatine bones.

The teeth of the lower jaw occupy the dentary bone and the lingual bone—teeth being also present upon the inferior pharyngeal bones, the branchial arches and the superior pharyngeals.

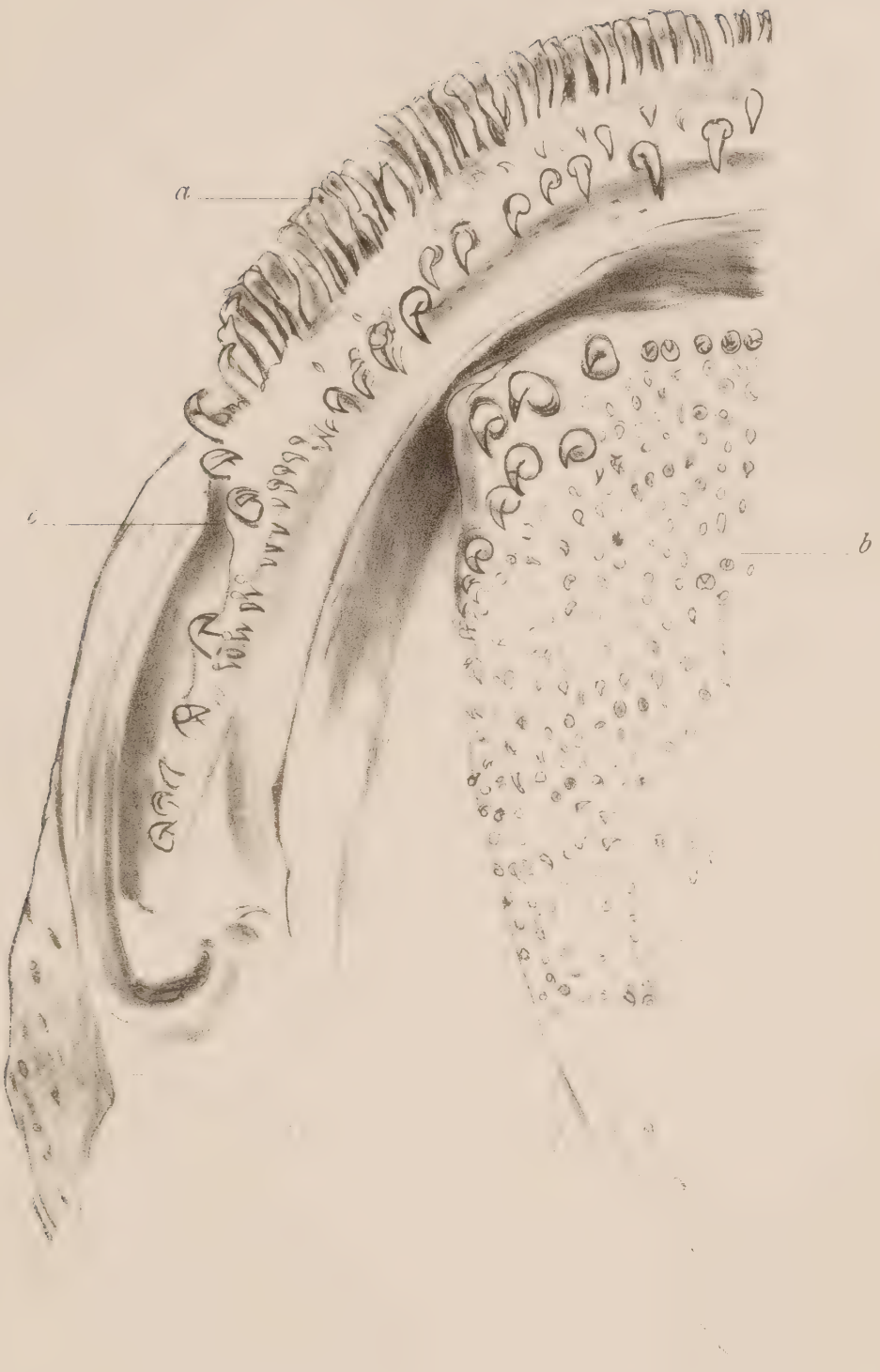
The lower teeth are arranged in four or five more or less distinct rows, the larger teeth occupying the front row and the smaller the inner row. The last eight teeth of the anterior row on each side are more widely separated from one another, and appear to be arranged in two groups of four teeth with an interval between them.

The whole series of lower teeth is interrupted at the symphysis by an edentulous space about the width of two of the larger teeth.

The lingual bone is covered with minute teeth arranged in lines radiating from behind forwards; these teeth are uniform in size, and on microscopical examination are seen to have the same shape as the other teeth of the lower jaw. The asperities of the tongue referred to in different species of echeneis which are spoken of as rough or smooth tongued, are caused by these pointed teeth.

The inferior pharyngeal bones are crowded with minute teeth of the same shape and structure.

On the concave surface of the branchial arches looking towards the gullet, are three or four




*Palatine aspect of right side of upper jaw.*

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rows of bony processes or tubercles arranged at regular intervals and covered with similar minute conical teeth (fig. 7). The armature of the mouth and pharynx is completed by similar minute recurved teeth covering the superior pharyngeal bones.

Histologically the teeth of the echeneis consist of vaso-dentine of an imperfect character, containing very few vessels, exhibiting lamination parallel with the long axis of the tooth and armed with a very sharp point of clear apparently structureless enamel.

*Mode of attachment.*—This is quite distinct from that described in any other fish of the family Scomberidæ.

Each tooth (and the description applies to all the teeth in the mouth, including those upon the tongue and branchial arches) is attached to the summit of a special bone of attachment—but is not anchylosed to it; it slides freely upon the bone and exhibits, as I have found, a modified form of hinge (figs. 3, 4 and 5, Plate I.). The summit of this process of bone is in the form of a convex ring slightly raised on one side—resembling the ball of a ball-and-socket joint with the centre cut out, leaving an elevated ring of bone. The base of the tooth is accurately adapted to this surface and slides easily upon it, forming the concave surface of

the joint; the opening for the passage of the tissues of the pulp is large, to allow of the movements of the tooth taking place without injury to the nerves and vessels. A capsular ligament surrounds the whole, giving a still greater likeness to a ball-and-socket joint. The capsule is strengthened anteriorly and posteriorly by a fibrous band, there being a distinct depression on the bone, and also on the tooth for the attachment of these fibres. It will be seen that this arrangement would allow of a sliding movement of the tooth on the bone of attachment in every direction, but the ring of bone being slightly more elevated on the anterior aspect the motion is limited in this direction more than in the opposite, and the tooth can be bent over much more in the direction of its point than in any other direction—the strong ligamentous band being stretched, no doubt serving to draw the tooth into position again.

Not being able to study these teeth in the fresh state, but after many years' immersion in spirit, one is unable to estimate with certainty the amount and ease of movement. The amount of bending down of which these teeth are capable does not appear very great, especially when compared with such complete forms of hinged teeth as those of the hake and pike; but when the minute teeth are examined under a hand lens

and pushed inwards with a needle, they are seen to be distinctly depressed and recover their position immediately on removal of the pressure, while owing to the shape of the pedestal they resist pressure in the opposite direction.

The amount of movement is quite sufficient, associated with the strong inward curve of the tooth, to make escape very difficult or impossible for any small creature captured as prey which would meet with no obstruction in passing over the crowns of the teeth in entering the mouth. The teeth examined for this purpose were immersed for some time in glycerine. Mr. Charles Tomes, in "The Dental Anatomy," says (p. 223), "a large number of fish have their teeth attached to short pedestals of bone by means of a sort of annular ligament which allows of a slight degree of mobility; by the limitation of this ligament to one side, we pass by easy transitions to those more specialised arrangements characteristic of hinged teeth."

In the echeneis, then, we appear to have another stage in the transition from anchylosed to hinged teeth, for here there are ligamentous bands in addition to the capsule, directing the motion of the teeth chiefly in a particular direction, and the shape of the opposed surfaces, above described, would appear to be of especial value in giving to this form of hinge as free a motion as possible.

The usual mode of attachment in the Scomberoids is by anchylosis to a socket, in the mackerel (Scomber scomber) the teeth are firmly anchylosed to the walls of the socket in which they are inserted. The transition appears to be very great from this form of implantation to that now under consideration, where the teeth are elevated on processes of bone and all alike are detached from their pedestals, so that the echeneis, in respect to its teeth, would seem to depart very widely from the type of its family.

The existence of similar teeth upon the branchial arches, where they cannot be of any great functional value, if any, to their possessor, would perhaps indicate that they are an example of retrogression from a fish with more highly specialised hinged teeth, and fitted to maintain an entirely independent existence. Dr. Günther has remarked that fish make considerably more use of the teeth on the branchial arches than has generally been supposed. He has noticed that on inserting the finger into the throat of a living fish it has been distinctly grasped by the teeth on the pharyngeal bones and branchial arches.

An examination of the contents of the stomach in both specimens showed large numbers of agglutinated round bodies and portions of minute crustaceans. In the stomach of one I found one of the ocean Entomostraca in an entire

condition, and these rounded bodies appear to be the ova of these crustaceans, the envelopes of the ova having apparently resisted the action of the digestive fluids. The shark, in common with other large fish, is much infested with parasitic crustaceans which adhere firmly to the skin; this fact, and that of crustaceans being found in the stomach, may throw some light perhaps upon the uses of the peculiarly shaped teeth of the front of the upper jaw, which appear to have a more limited amount of movement on their pedestals than the recurved teeth in the other parts of the mouth.

Edwards ("Gleanings," p. 210) "believes the echeneis feeds on the slimy substance it finds on the skins of the greater fishes." When the sucker at the back of the head is pressed against any flat surface, the range of spatula-shaped teeth in the upper jaw lie in contact with that surface.

A forward motion of the fish, which the sucker readily allows, causes these teeth to rake the surface to which they are applied, and anything so detached will fall upon the projecting lower jaw and its array of hooked and hinged teeth, from which active prey would be unable to escape.

A very slight propulsive force causes the sucker to slide forwards, so that the fish would

have no difficulty in progressing over the shark's body in this manner.

The peculiar mode of attachment of the teeth would suggest that fracture or injury to the teeth would be prevented by the hinged socket allowing them to ride over an obstruction—much as a horse-rake with independent teeth accommodates itself to the uneven surface of a field.

Although, as referred to above, Bennett speaks of the sucking fish as only fixing itself to the shark occasionally, and for a short time, it retains its hold during the tremendous disturbance caused by the capture of the shark, and this fact, together with the shape and arrangement of the teeth, and the protective colouration before referred to, would seem to indicate that the echeneis is much more adapted to a semi-parasitical mode of life than to a free and independent existence.

Its habit, however, of occasionally detaching itself and foraging for food on its own account, would be quite comprehensible from the arrangement of the teeth, which would provide not only for this scouring of the skin of the shark by means of the hoe-like teeth, but also for the capture of such active animals as the free swimming crustaceans which are found in such abundance on and near the surface of the ocean

in the tropics, by means of the strongly recurved, pointed and movable teeth found in the rest of the mouth and admirably adapted to secure quick moving prey.

In a much larger specimen of echeneis, measuring one foot in length, which has since been sent to me from Australia, and which has seventeen laminæ in the sucker, I found the stomach contained the backbone of a fish $2\frac{1}{2}$ inches long —occupying, in fact, the whole length of the stomach—showing that the fish can prey on large and active animals.

With regard to the tongue—it appears that the roughness or smoothness of the tongue has been made use of by some naturalists as a specific character; but Dr. Günther considers that neither this nor the form of the caudal has any specific character, and adds that specimens with distinct asperities on the tongue are comparatively rare. In both my specimens found in the Atlantic there is a rough tongue, and also in the larger specimen from Port Jackson—the roughness being caused by minute conical recurved teeth implanted in the same manner as the larger teeth. It appears possible that in some specimens in which the teeth are very small they might not be noticed by the finger as asperities, or from their mobility they may have been pressed downwards in passing the

finger over the tongue, and the specimen described as smooth-tongued, although the lingual bone was covered with minute teeth.

I have not have had an opportunity of examining the teeth of the more common species, Echeneis remora, found in the Mediterranean, which in size and general configuration is very similar to the species described. The peculiarities of the dentition of the echeneis appear to be :—

The peculiar shape and position of the anterior upper row of teeth, suited to its semi-parasitical habits.

The attachment of the teeth to the bone by a modified ball-and-socket joint, with a capsule strengthened anteriorly and posteriorly by fibrous bands.

The existence of this form of attachment throughout the whole series.

## DESCRIPTION OF PLATES.

PLATE I., FIG. 1.—ECHENEIS SQUALIPETA? NATURAL SIZE.

PLATE I., FIG 2.—MARGINAL TEETH.
(*a*) Tooth; (*b*) bone of attachment.

PLATE I., FIG 3.—TOOTH FROM LOWER JAW—SLIGHTLY TILTED FROM POSITION ON BONE TO SHOW FORM OF OPPOSING SURFACES.
(*a*) Part of capsule; (*b*) capsule containing fibres, forming hinge; (*c*) bone of attachment; (*e*) enamel tip.

PLATE I., FIG 4.—AN OLD TOOTH WITH SMALL PULP CAVITY—SHOWING THE CAPSULE RUPTURED.
(*a*) Tooth; (*b*) bone of attachment.

PLATE I., FIG 5.—TOOTH FROM LOWER JAW.
(*c*) Position of hinge; (*d*) capsule ruptured anteriorly; (*b*) bone of attachment.

PLATE I., FIG 6.—PEDESTALS OF BONE OF ATTACHMENT FROM WHICH TEETH HAVE FALLEN OFF, SHOWING RING OF BONE IN VARIOUS STAGES OF ABSORPTION.

PLATE I., FIG 7.—MINUTE TEETH ON BRANCHIAL ARCHES—ARRANGED IN TUFTS.

PLATE II.—RIGHT HALF OF THE UPPER JAW.
(*a*) Marginal teeth; (*c*) recurved teeth of inner row; (*b*) vomer.

## Discussion.

Mr. Tomes asked as to the position of the fish when attached by its sucker, whether it was tolerably parallel with the body of its host, or stood off at an angle. A point that occurred to him as possible was that the fish might be able to protrude its mandible somewhat, and so make use of the re-curved teeth as scrapers. With reference to the sort of ball-and-socket joint with its capsular ligament, he had been accustomed to think that a very large number of teeth, particularly amongst fish, were ankylosed to their sockets, but since he had obtained a rather more extended acquaintance with them he found actual ankylosis was not so very common. It was a very common thing indeed for a tooth to be fitted on to a sort of pedestal with a kind of annular ligament round it; and in teeth which were used with great force, like the crushing teeth of the common bass, it was by no means uncommon to find an elastic pad between the tooth and the bone on which it stood, which probably saved the tooth from being easily broken when put to severe use. The material was to hand in echineis for the manufacture of a sort of modified hinged tooth. It was common to find that sort of annular ligament present in some degree to strengthen and thicken and alter the strength of the surfaces.

Mr. Storer Bennett said he had had no opportunity of examining the teeth of echineis, and therefore was incompetent to speak on their method of attachment, but anyone who had examined the mouths of many fishes would be quite aware that this kind of attachment of teeth was common on the dentary, the lingual, and the pharyngeal bones, and the gill arches of a good many fish. Ten or fifteen years ago he made a great many

sections of a good many fishes, and was surprised to find how frequently hinged teeth were met with. The recurved teeth with a modified form of hinge were very common, and showed frequently what Mr. Mummery had drawn upon the screen, the pedestal with a movable tooth, and a capsule surrounding it.

Mr. Goadby asked about the structure of the upper front teeth, whether they corresponded with the other hinged ones. He also wished to know the character of the enamel tip on the front teeth, and also the arrangement of the dentine. Was it the same sort of layer of fibrous dentine next to the pulp that the hake had?

Mr. W. R. Barrett said Mr. Mummery mentioned that the teeth moved better in the backward than in the forward direction, and attributed it principally to the arrangement of the pedestal of bone and the ball-and-socket arrangement between the tooth and the bone. It seemed to him (Mr. Barrett) that the lengths of the fibrous bands of the annular ligament had a great deal to do with the movement. From the diagram it would seem that when the teeth were in the upright position, the posterior band was quite taut, whereas the anterior band bulged out, so that the teeth could not be pressed any further forwards but could easily move in the backward direction.

Mr. Mummery, in reply, said that he did consider the fibrous bands to be of great importance, because the movement of the teeth was chiefly due to them and they strengthened the capsule on either side. Whenever the teeth bent down, there was a bulging of the band on the side towards which the tooth was bent. In answer to Mr. Goadby, the enamel appeared to be quite structureless, and came down almost to the tip of the pulp of the tooth. He was well aware of what Mr. Bennett had said, that the capsular attachment in fishes was very common. He thought that the strengthening bands, front and back, were stronger in the echineis than they were in most fish. It was a stage further towards hingeing, and the interest in the echineis was more with regard to the habits of the fish, especially with regard to the front row of teeth. It appeared

to be a very interesting example of adaptation of structure to the conditions of existence. In answer to Mr. Tomes, he did not quite see how the teeth of the mandible could act as scrapers. The teeth would not come in contact with the skin of the shark unless the jaw could be protruded, and if it did the curved backs of the teeth would be against the shark's skin.

The PRESIDENT having tendered the thanks of the meeting to the readers of papers, and those who had taken part in discussions, adjourned the meeting until February 6.

# Odontological Society of Great Britain.

## ORDINARY MONTHLY MEETING,

*February* 6, 1899.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

The SECRETARY read the Minutes of the last meeting, which were confirmed.

The following gentlemen were proposed for election into the Society:—As a resident member: CLARENCE H. KEALL, L.D.S.Eng., 31, Clarendon Road, Bayswater, W. As a non-resident member: SIDNEY HERBERT WILLIAMS, L.D.S. Eng., Johannesburg, South African Republic.

The following gentlemen were balloted for and duly elected:—As resident members: EDWIN WILLIAM HARWOOD, L.D.S.Eng., 97, Sloane Street, S.W.; MURRAY THOMSON, L.D.S.Edin., 147A, Harley Street, W.; TRAER HARRIS, M.R.C.S., L.R.C.P., L.D.S., 112, Harley Street, W. As a non-resident member: JAMES MOUNTFORD, L.D.S.Eng., 24, Bennett's Hill, Birmingham.

The CURATOR (Mr. Storer Bennett) said he had one specimen to present to the Society, which had been handed to him by Mr. West. It was a remarkable specimen of an upper and lower entire set, metal plates with the teeth soldered on, and with springs, but the curious part of it was that the swivels were attached by the pins being inserted into the first molars. He used the expression

"being inserted" because it was rather difficult to know quite how they were attached to those teeth—whether holes had been drilled into the teeth and the pins passed through them, or whether the teeth were originally formed with the holes for the reception of the swivels. He was informed that the plates were made a good many years ago, but the date of them was quite problematical. He had certainly never seen any teeth made for the purpose of receiving bolts of swivels in that way, and had never seen any plates with the swivels attached in the same manner.

The PRESIDENT said it was quite possible the teeth were made with pins in them, and he thought it likely that the swivels were made in that way.

Mr. COXON said that the teeth exhibited by Mr. Storer Bennett were tube teeth with a cross-section made in them for putting in swivels, and he knew that he could find two teeth with the swivels inserted in them that belonged to his predecessor. One of the teeth had always struck him as very peculiar; it had tubes running through it in the horizontal as well as in the vertical directions, the former he thought being made to carry a swivel.

Mr. REINHARDT said it might possibly be that the hole in the tooth was drilled afterwards by the man who made the set of teeth. Many years ago, before the engine came into use, it was not an uncommon thing for a man to have to drill holes in artificial centrals and laterals and put in gold fillings. It was very slow work; it was done by means of a steel drill tempered very hard indeed, turpentine being used with the drill.

## CASUAL COMMUNICATIONS.

Mr. MATHESON read a short communication on "Obtundents." He said: I must apologise for the title of my communication, inasmuch as it might be taken to indicate much wider ground than I propose to cover. As it is, I shall confine my remarks to the consideration of two drugs; one very familiar and the other not, I think, so widely known or used.

Nitrate of silver is a substance which I suppose we all use more or less for the arrest of caries and for the obtunding of sensitive dentine exposed by caries, by abrasion or erosion. I suppose we all have our favourite methods of applying it, and I suppose we are always seeking about for some more convenient method than we already possess for applying the drug in difficult positions.

There is the ordinary pencil of lunar caustic; there is the powdered drug; there is the silver probe with a coating of nitrate of silver fused on its end—a very convenient form of which was shown by Mr. Sidney Spokes at the meeting of a kindred Society a few days ago; and there is the flexible platinum loop for holding the solid salt, as described by Mr. Stevens. These are some of the means by which nitrate of silver can be applied. I should like to mention also the pencil used by ophthalmic surgeons, which I have found very much better than the ordinary pencil on account of its smallness. I venture to hand this round, for though it is nothing new I have found that a good many operators are unfamiliar with it.

I use nitrate of silver a good deal to reduce the extreme sensitiveness of the dentine so often found in cervical cavities and in the small coronal cavities of second and third molars only recently erupted. In such cases, nitrate of silver acts as a valuable obtundent when it can be sealed in the cavity for a short time. Such cavities, however—especially the cervical ones—are often so very shallow that it is occasionally a matter of some difficulty to apply the nitrate conveniently. It may be applied in the form of powder taken up on minute pads of blotting paper, which can then be sealed in with Fletcher's artificial dentine; and for some time I have been using for this purpose blotting paper previously steeped in a saturated solution of nitrate of silver, and then dried and cut into pieces of suitable sizes. But I have not, so far, been satisfied with the amount of the drug taken up by the blotting paper, so that although in some cases I use the medicated paper with a certain satisfaction, the quantity of the drug it contains is not

sufficient to obtain such good results as are possible when the powdered salt is used. I have tried to load the paper more heavily. I have attempted to do this with a paste made of powdered nitrate of silver and a thin solution of gum tragacanth in water. The paste is smeared on a thin layer of paper fibre lint or between two sheets of the thinnest bibulous paper. But the tragacanth has failed to hold together the powdered nitrate and the two layers of bibulous paper in the way I hoped it might do, so that this preparation is very little, if any, improvement on the original steeped paper.

It has, however, been suggested to me by Mr. Waller, the chemist of Great Marylebone Street, that a paste of nitrate of silver with glycerine and a small percentage of non-organic earth might answer the required purpose, the glycerine, by the permanence of its moisture, keeping the nitrate together in sufficient bulk. Mr. Waller has prepared this paste and has spread it on paper fibre lint and between sheets of bibulous paper. It promises well, but it has only just come into my hands, and I am therefore not able to report on it as I had hoped to do to-night. I shall take an opportunity of giving the Society at a future meeting the results of my experiments with this new preparation.

The other drug about which I wish to make a few remarks is the so-called milk of magnesia. My attention was directed to it some two years ago, in a report of the Seventh District Dental Society, State of New York. In a paper read before that Society by Dr. C. B. Ireland, the author says :—

"Chemical examination of this product shows it to be a pure hydrate of magnesia, *odourless*, *tasteless* (barring the slightest astringency), in fluid form, and absolutely free from grit. It is homogeneous, milk-like in consistence, and is simply and solely water and magnesia, representing twenty-four grains of magnesia hydroxide in each ounce of distilled water. Being a hydrate, it possesses the *greatest possible affinity for acids*, a given amount neutralising an equal volume of fresh lemon-juice. . . .

"Subsequent to cleaning the teeth, if a teaspoonful or more, undiluted, is taken into the mouth and quietly floated about, the acids present will not only be neutralised, but, owing to its peculiar clinging, semi-gelatinous nature, a slight alkaline film is left on the teeth and in every little pit, fissure, and retaining centre of fermentable material, sufficiently adherent to afford protection against acidation for three or four hours during the waking hours, six or more during sleeping hours, and all this without any care being necessary on the part of the patient,—hence its ease of application in children. . . . During pregnancy, when the teeth are suffering severely from being constantly bathed in an acid saliva, and frequently flooded with acid regurgitations from the stomach, or in cases where buccal and lingual ulcerations are associated with gastro-intestinal acidity, the conjoined local and internal use of this preparation is attended with the most immediate and satisfactory results.

"Its local use is of great value after partaking of acid fruits, sour wines, or medicinal acid compounds, and particularly invaluable after drinking milk just before retiring, in preventing the lactic fermentation which, while it may not produce caries, will, if continued, result in excessively sensitive teeth. That extreme sensitiveness of the teeth caused by the attachment of partial artificial dentures, particularly when clasps are employed, will be markedly minimised when this preparation is employed."[1]

I have ventured to make these quotations for the benefit of those members of the Society who may not have seen the paper referred to, nor happened to meet with an account elsewhere of this form of magnesia.

I have myself used it now in a number of cases during the past two years, and I have formed a strong opinion as to its merits. I cannot offer any actual proof of its efficacy in checking the processes of decay and erosion of the teeth, but it appears to me highly probable that it

[1] *Dental Cosmos*, vol. xxxix. (1897), p. 552.

does definitely help to check or retard those processes; and I have certainly proved to my own satisfaction that it markedly reduces the sensitiveness of dentine exposed by erosion and abrasion, by recession of the gums and by caries. The weak spirits of wine or eau de cologne that I have hitherto been in the habit of using for such cases I am gradually discarding in favour of this milk of magnesia, inasmuch as it has the advantage—over the eau de cologne at any rate—of not discolouring the surfaces of exposed dentine.

I recommend its use according to the manner originally advised in the paper I have quoted from; that is, a teaspoonful or so held in the mouth, and drawn in and out between the teeth for a full minute or more, after the teeth have been cleansed in the ordinary way. I urge the use of the milk regularly at night before retiring to rest, and more frequently in severe cases. The preparation is made by the Phillips Chemical Co., of New York.

The PRESIDENT asked what form the milk of magnesia was in?

Mr. MATHESON said it was contained in a bottle. The hydrate was in suspension in water and separated to a certain extent sometimes from the water, but if shaken it mingled again with the water, and one found it in a milky form, and if poured out in a tumbler it was very like milk. The way of applying it was by taking a teaspoonful or so into the mouth and holding it there, and drawing it in and out between the teeth for a few minutes. He had not tested the condition of the oral fluids after its use.

The PRESIDENT thought that nitrate of silver was most useful, and he entirely endorsed what Mr. Matheson had said with regard to its use. It seemed to him that the speediest and most certain of obtundents for sensitive cavities in teeth was the hot-air syringe. It was rather a painful obtundent, but he had never known it fail.

Mr. RUSHTON said there was a danger of the nitrate of silver stick going down the throat. He asked Mr. Matheson what was gained by mixing a diatomaceous earth with the nitrate of silver and glycerine. He should have thought the purer the drug the better.

Mr. Read said the risk of swallowing the nitrate of silver could be easily overcome by using a small piece of platinum wire. Silver corroded if it were used much, and he therefore preferred a small piece of platinum to hold the nitrate of silver.

Mr. Dolamore understood Mr. Matheson to say that the milk of magnesia had been found to check the progress of erosion cavities. He should like to ask whether he had any data to give on that point, because personally he had always doubted whether there was such a thing as erosion apart from attrition. Of course, milk of magnesia could not stop the progress of cavities due to attrition, and if it stopped the progress of erosion cavities it would be an argument in favour of the disease producing erosion apart from attrition.

Mr. E. Lloyd-Williams said he would be pleased if Mr. Matheson in his reply would refer to the reasons that induced him to use powdered nitrate of silver and why he objected to a strong solution of nitrate of silver which one would have thought applied to a dry surface would be a great deal more efficacious than the powder. Personally he had used a strong solution of nitrate of silver in carbolic acid. By simply rubbing a small pledget of cotton wool dipped in carbolic acid on a stick of nitrate of silver, a syrupy solution was obtained, which he had always found very efficacious. He would also like to ask Mr. Matheson what his theory was as to how an alkali could act as an obtundent. It was very interesting, and he did not doubt the fact for one moment. He should also like to know if magnesia had any specific action in that way and whether he had tried any other alkalies, and if he could explain their value.

Mr. Coxon asked if Mr. Matheson had ever used zinc chloride and whether he thought it was a useful drug? It was an obtundent to a certain extent.

Mr. Matheson, in reply, said that with regard to the zinc chloride he might say that in his early student days and early practice he did use zinc chloride, and he found the remedy was very much worse than the disease. With regard to Mr. Lloyd-Williams' questions, he might say with

reference to other alkalies, or alkaline washes, that he had not made any, or certainly not much, use of them because he had always felt that their effects were so fugitive, that was to say, you might have an alkaline wash which would deal with the conditions at the moment but no permanent alkaline effect was obtained. That was what attracted him about milk of magnesia—the idea of the film on the teeth which, if it were there, must have a more considerable effect at all events than any wash applied at the moment. With regard to any theory as to an alkali being an obtundent, he had not formed any such theory, but he believed that an ounce of practice was worth a pound of theory, and it was in practice that he had found this preparation so useful. He was quite willing to admit that the term obtundent was perhaps not properly applicable. Certainly he had not used it as some had used it that evening, meaning that milk of magnesia was an obtundent which would reduce sensitiveness of dentine so much as to take away the pain caused by operating. He had used it for the reduction of the sensitiveness which a patient felt without operation—sensitiveness to heat and cold and sweet and salt substances, a condition which was always very difficult to deal with. He should expect the dentine to be less sensitive to the excavator after the use of the milk of magnesia for some weeks, but he certainly should not expect it to be obtunded as dentine was obtunded by the use of nitrate of silver. One could treat such a condition with nitrate of silver, but in most cases this drug could not be used in the front of the mouth, and there were objections to the use of spirit of wine. With regard to the question as to why he should not use a saturated solution of nitrate of silver, he might say that he had used it for a considerable time some years ago. He kept the saturated solution in a bottle, but he found the salt so apt to crystallise and so apt to fly in an unpleasant way when he opened the bottle that he gave it up. He was obliged to Mr. Lloyd-Williams for the simple way of forming a saturated solution which he had described. It had always occurred to him that if some preparation of the nitrate could be used in the form of little pads, as it

were, it would lend itself to that particular kind of case which he had spoken of, namely, very sensitive cervical cavities. Mr. Dolamore had mentioned that he understood him to say definitely that milk of magnesia did check erosion. He tried carefully to say that he was not pre-prepared to prove that; he only said he thought it did. It was so very difficult to prove any actual checking of erosion without the most careful and minute measurements that he was not prepared absolutely to say that it did, nor had he taken any means of measuring the erosion cavities as he might have done. Perhaps he might be allowed to say, with reference to Mr. Dolamore's belief that erosion was only caused by attrition, that only two days ago he (Mr. Matheson) removed a left maxillary third molar in which there was considerable erosion of the buccal and disto-buccal cervical margin. The erosion was remarkable for having a very high polish, such as one sometimes saw, but which he thought he had never seen in such a position. But high polish or no high polish, it was very difficult to see how it would be possible in such a position to have erosion caused by attrition. As to why it was proposed to mix nitrate of silver with a diatomaceous earth as well as glycerine, he was informed by the chemist who was kindly preparing it for him that it worked up better in a paste. The nitrate of silver was present there in the proportion of 80 per cent. With regard to the length of the pencil, he might say that he put in a new pencil just before coming down, and the same thought occurred to him that it would be dangerous to use it as it was, and he never should so use it. A smaller piece, only projecting one-sixteenth of an inch, was what he generally used.

Mr. W. Rushton showed a new arm-rest which enabled an operator to work from the back of the chair. The arm-rest was made by the Dental Manufacturing Company, and could be raised in height or be taken away altogether. It could be also moved in any way one liked, backwards and forwards. The rest could be placed on any chair.

Mr. Cornelius Robbins mentioned a combination back-piece head-rest and arm-rest, one which he had just had fitted to a new chair. The idea, he thought, was partly due to Mr. Matheson and partly to Mr. Preedy. The amount of comfort both to himself and patients was very great. The back and head-piece was all in one.

Mr. Matheson disclaimed any credit for the idea put forward by Mr. Robbins. It went back much further than he could do—it went back to the days of Mr. Alfred Woodhouse and Mr. Campion, to the use, in fact, of a chair without a head rest at all, but with a back the top of which was slightly hollowed out and slightly padded, but not to the same extent as that which Mr. Robbins had mentioned. The only way in which his (Mr. Matheson's) chair differed from those used years ago by the gentlemen he had mentioned was in the fact that his chair was a combination of the White and Wilkerson patterns. It had a movable back, and he attached to that back the top which he had been familiar with as used by Mr. Woodhouse and Mr. Campion. He was glad Mr. Robbins had raised the question, because he thought it would be very interesting to hear how many operators did use a head rest, and how many found that they got much more comfort to their patients, and quite as much convenience to themselves, by doing away with head rests and by simply having the top of the chair so arranged and padded that they could do without a head rest. There was one difficulty connected with the lack of a head rest, and that was that people with round shoulders did not get convenient support for their head. He got over that difficulty by putting a soft cushion underneath their shoulders, so supporting the back of their head.

Mr. Preedy said the idea was suggested to him after seeing Mr. Matheson's chair, and he should be very pleased to show his chair to any member of the Society.

Mr. Percy Smith said he had had the opportunity lately of being two or three times in a chair designed by Mr. Matheson, and it was most comfortable to the patients.

Mr. Theodore Harris exhibited models showing sup-

pression of most of the permanent teeth. The patient was 23 years of age, of medium height and build, and well nourished. He said that, as far as he knew, he had the usual number of temporary teeth, but had lost most of them, and had been wearing a lower denture for some years. The only permanent teeth in the maxillæ were the two central incisors, one lateral incisor, and the two first molars. In the mandible there were only three permanent teeth, one central incisor, and two teeth occupying the place of the lateral incisors, which he took to be canines from their shape and size.

The PRESIDENT said it was a very interesting question in cases of suppression of teeth whether the character of the patient was like the jaw.

## *The Relations of Dental Diseases to General Diseases.*

By William Hunter, M.D., F.R.C.P.

It is now some ten years since, in the course of a somewhat detailed study of the pathology of the severest forms of anæmia, my attention was drawn to the mouth as a possible source of the infection which, according to my observations, undoubtedly underlies these forms of anæmia.

At the International Congress of Hygiene held a year or two later, one of the papers in the Section of Bacteriology, presided over by Lord Lister, which interested me most was one by Professor Miller, of Berlin, entitled "The Mouth as a Source of Infection."

Since that time the subject has maintained its hold on my interest on two grounds: firstly, in relation to the pathogeny of anæmia; secondly, in relation to infection generally, of which dental caries is, in my opinion, the most common example to be found in the human body.

When, therefore, your Secretary approached

me with a request to contribute a paper to your Society he found the ground was prepared. I consented willingly, and for two reasons; the first being that I was anxious to submit the few observations I had been able to make to the criticism of this Society; the second, that I was anxious to learn how far the wide experience of dental surgeons bore out the conclusions derived from the much more restricted experience of the physician as to the importance of dental diseases in relation to general diseases.

While still thinking of the subject I was fortunate enough to have a case which, so far as I was concerned, brought to a head my interest in the subject, and satisfied me of the importance of this relationship in infective gastritis; and the observations in this case may serve as my chief contribution to the subject of our discussion to-night.

The subject is one of very great practical importance, greater perhaps to the physician than to the dental surgeon, and is, I venture to think, not yet so fully recognised as it ought to be. To no one are we more indebted in this relation than to Professor Miller, of Berlin, whose prolonged researches on the bacteriology of the mouth and teeth have thrown a flood of light on the importance of the mouth as a possible source of infection in many diseases. There is no lack of

material to illustrate this fact. To adduce the facts in detail would be only to repeat and amplify what has been already so well done by others.

To-night I propose, therefore, to confine my remarks within certain defined limits, to pass over briefly those diseases whose relation to dental disease is obvious and well recognised, and to direct attention to those—in my opinion, no less important—where this relation is not so clear, yet probably hardly less close.

### *Relation of Dental Disease to Indigestion.*

That health is to a very great extent conditioned by the state of the teeth—their presence or absence, their freedom from pain—would probably be admitted by all. But if inquiry were made as to the nature of this connection, I suspect it would be found that in the minds of most the relation is chiefly what one might term a *mechanical* one.

Carious teeth mean imperfect mastication, and this in time, by throwing unnecessary work upon the stomach, leads in time to all the many ills and worries attendant on impaired digestion.

It is not this subject that requires to be dwelt on. It requires no further elucidation. This mechanical relation, however, by no means ex-

hausts the relationship of dental disease to gastric disease, as I shall presently show.

*Relation to Reflex Nervous Disturbances.*

Another group of affections whose relation to dental disease is obvious, and which may be noticed in passing, are the various disturbances of a reflex nature so common in dental disease, *e.g.*, headache, neuralgia, spasms of facial muscles, spasms and paralysis of ocular muscles, ptosis, strabismus, disorders of accommodation, or still more generalised effects, such as convulsions or paralysis.

*Relation to Infective Diseases.*

This is the branch of the subject I consider to be the most obscure, and the one whose importance is not sufficiently recognised, and it is the one that I desire specially to dwell upon to-night.

The subject of most obscurity is the relationship between dental diseases and the whole class of cases of infective nature, such as osteomyelitis and acute necrosis occurring apart from injury, idiopathic meningitis, empyema in children, ulcerative endocarditis; or, more obscure cases presenting the general characters of a blood-poisoning.

The special interest and importance of this class of case in relation to dental disease arise from the fact that dental caries, and suppurations

connected therewith, present us with the most complete examples of mixed infection that we find in the body. The organisms concerned are very many and various, some harmless, others very virulent. Moreover, while many of the organisms are harmless, others constantly present include the most virulent pyogenic organisms, *e.g.*, the staphylococci and the streptococci.

*Bacteriology of Dental Caries.*

On this point—the infective nature of dental caries—I need not dwell. The evidence so abundantly furnished by the laborious bacteriological observations of Miller (1884-1894), on no fewer than 250 cases of diseased teeth; Galippe and Vignal (1889), Jung (1893), and most recently of all by Professor Arkovy of Budapest (1898), is to my mind overwhelmingly conclusive on this point.

The observations of the last mentioned seem to me to be of such particular importance that I venture to summarise them very briefly. They extend from 1878.

He has studied in detail the organisms found in the following conditions :—

(1) Chronic alveolar abscess, with and without parulis.

(2) Gangrene of pulp, both acute and chronic.

(3) Old stoppings removed after varying periods of time.

(4) Chronic alveolar abscess with circumscribed alveolar necrosis, after previous root stopping.

His method was as follows :—

After complete evacuation of the pus from the abscess cavity, or removal of the gangrenous pulp from the pulp cavity, and out of the root as far as the apical foramen, all parts were thoroughly disinfected, first, with 1 per cent. corrosive sublimate, and then with pure carbolic acid, and then thoroughly packed with a jelly-like mixture of camphor, pure carbolic and oil of eucalyptus, and the whole closed in with a covering of asbestos and gutta-percha. In this condition the tooth was left some three to six months before the definitive filling was proceeded with.

Many cases under this treatment healed entirely, and he regarded them as sterile. A small minority still presented some degree of parulis or chronic periostitis remaining; and the cause of this he endeavoured to ascertain by careful cultivation, the pathogenic properties of the various cultures being determined by experiments on animals.

The number of cases examined in this way was forty-three; and the chief result of his observations is to show that the organism most

constantly present in diseased pulps and in dental caries is a bacillus to which he gives the name of *Bacillus gangrænæ pulpæ*. Its relative frequency, as compared with other organisms, is 95·3 per cent. of all cases.

Next most frequent is the *Staphylococcus pyogenes aureus* in 34·8 per cent. of cases; then the *Streptococcus pyogenes* in 23·2 per cent. of cases; then *Staphylococcus pyogenes albus* 18·6 per cent.; S. pyogenes citreus, 4·6 per cent.; Bacillus pyocyaneus 9·3 per cent., and some nine other organisms, mostly harmless, in varying frequency.

Morphologically the characteristic feature of B. gangrænæ pulpæ is that it is pleomorphic, forming bacilli, when grown on gelatine, cocci when grown on agar agar.

As regards pathogenic action, pure cultures of this organism were found to possess the power, single-handed, of producing gangrene of the pulp; never suppuration unless other organisms were present.

A further important observation made was, this organism could effect a softening of the tooth, even in an alkaline medium, a fact which, if confirmed, would dispose of the view widely prevalent regarding dental caries, viz., that the first decalcification is the result of the action of an acid.

The organisms found in carious dentine after sterilisation were: *B. gangrænæ pulpæ* in every one; *S. pyogenes aureus; Streptococcus pyogenes;* B. pulpæ, the only constant.

The pyogenic organisms were always absent in teeth properly dealt with antiseptically.

*Relation to Local Infective Diseases.*

This group includes not only the various complications of diseased teeth met with in the bones of the jaw, the gums, neighbouring maxillary sinuses, *e.g.*, alveolar abscess, suppuration in the sockets (pyorrhœa alveolaris), periostitis, osteitis, osteomyelitis, necrosis of bone, suppuration in maxillary sinuses, but also inflammations and suppuration in neighbouring parts by direct extension, such as inflammation, and at times suppuration of lymph glands of neck, cellulitis of neck, post-pharyngeal abscess, thrombosis of veins, meningitis.

This group of cases may, perhaps with one exception, be excluded from our field of survey to-night. Their relation to dental disease is obvious, and does not require any special elucidation.

Cases of this kind are not uncommon. A number are on record (one such came but recently under my notice) where after extraction of a tooth with a foul instrument a condition of

gangrenous stomatitis, osteomyelitis and necrosis has been set up, and death has ensued from pyæmia.

*Diseased Glands in Neck.*

One of the conditions above referred to deserves a more detailed notice, viz., the relation of dental caries to chronic glandular enlargements in the neck. To what extent may such enlargements be due in the first instance to conditions of decay in the teeth—to irritation set up by inflammatory conditions around the teeth in children; the chronically enlarged glands subsequently forming favourable seats of infection for tubercle bacilli, with all the troubles attendant on tuberculous glands of neck.

Odenthal[1] examined 987 children and found decayed teeth in 429. In 558 no decay.

Of the 558 without decayed teeth: glandular swellings in 275 = 49 per cent. Of the 429 with decayed teeth: glandular swellings in 424 = 99 per cent.

He was able to determine a constant relation betwixt the extent of the glandular swellings and the extent of the decay.

Wherever the pulp was gangrenous or highly

[1] Odenthal, 1887 ("Caries of Teeth as Centres of Infection and Cause of Chronic Glandular Swellings of Neck").

inflamed the glandular swelling was invariably more pronounced and extended.

The presence of a number of decayed teeth was always accompanied by very marked glandular swellings.

The most recent contribution to the subject is that of Hugo Starck, "Tuberculous Cervical Glands in relation to Carious Teeth" (*Munch. med. Woch.*, xliii., 1896).

He examined 113 children with glandular swellings of neck. In 41 per cent. he found carious teeth, and in almost all of these the situation of the glands corresponded to the affected teeth.

In three children with tuberculous glands of neck he also found carious teeth: but he could not discover any tubercle bacilli in these.

In a girl, aged 14, otherwise healthy, he found a molar tooth containing tuberculous granulation tissue, and tuberculous glands on this side, and this alone.

This case suggests the possibility of a causal connection betwixt carious teeth and tuberculous glandular enlargements, but at the same time suggests that a local tuberculous lesion of the tooth is necessary, and this is very rare.

So far as the mouth is concerned, by far the most important seat of infection for tubercle is the tonsil.

Not only are giant cells to be found in the tonsils in a considerable proportion of cases, —7 per cent. according to Cornil (*La Semaine medicale*, 1895, p. 223, 70 observations); but experiments have shown that tonsillar tissue, when injected into animals, is capable of giving rise to tuberculosis in a considerable percentage of cases—according to Dieulafoy 13 per cent. (*La Semaine medicale*, 1895, p. 199), sixty-one experiments on guinea-pigs).

Not only for tubercle bacilli, but even more for pyogenic organisms, does the tonsil play an important part as a seat of entrance.

According to Buscke ("The Tonsils as Portals of entry for Pyogenic Organisms," *Deutsche Zeitschrift fur Chirurgie*, 1894), the tonsils play a greater *rôle* in admitting pus organisms than even the skin or the mucous membranes.

He found staphylococci and streptococci in hypertrophied tonsils which were not seats of acute inflammatory change.

He gives the history of four obscure cases of suppuration, in which the tonsils were the probable seat of infection, one of them a case of uncomplicated simple fracture, which pursued a normal course for three weeks, by which time a large amount of callus was thrown out.

On the twenty-sixth day the patient fell ill with a sore throat, due to streptococci. Three

days later similar streptococci could be found in the blood, and on the following day the patient was seized with rigors and rapidly developed a suppurative osteomyelitis and periostitis at the seat of fracture.

*Relation to General Infections and Infective Gastritis.*

The class of disease whose relation to dental disease is not so clear and possibly hardly less important are (1) those of obviously infective nature, the only question being the channel by which the infection has entered the body—such affections as acute osteomyelitis and necrosis occurring apart from injury; empyema, meningitis, ulcerative endocarditis, some forms of acute nephritis; and (2) the whole series of cases of obscure nature probably infective, characterised generally by features of blood poisoning, and probably determined by some general infection, the origin of which cannot be made out.

When as sometimes happens, such cases can be traced to infection from diseased teeth, light is cast upon the whole subject of the *rôle* possibly played by dental diseases in many general conditions. One of these conditions I consider to be *sub-acute and chronic infective gastritis*. I cannot better illustrate the class of case I refer to than by describing to you a case recently under my observation.

*A Case of Sub-Acute Infective Gastritis secondary to Suppuration around Decayed Teeth.*

The case was that of a lady, aged 62, sent to me by Dr. Ferris, of Uxbridge, where she had been on a visit, with a history of having been ill for nearly a year; symptoms all referring to stomach, pain, sickness, and obscure abdominal distress, necessitating use of opium; loss of flesh; symptoms suggesting cancer of stomach, although no signs of growth could be detected.

She presented a wasted, somewhat cachectic appearance, with pale sallow complexion.

Next to the gastric pain, intermittent in character, she complained mostly of a constant bitter taste in mouth, a great loathing and distaste for food, an inability to taste her food, and a sense of nausea with occasional sickness, the sickness having no relation to food, coming on usually in the morning.

On examination I could not find any sign of malignant disease in abdominal or pelvic organs. The only physical signs of disease were to be found in the mouth. Her teeth had all been removed with the exception of four stumps. She wore two plates of false teeth, which were scrupulously clean. The gums, except around the four stumps, were quite healthy. These stumps presented a dark, rotten, dead appearance, and in the case of three of them, on pressure pus

welled out freely from their sockets through small pouting sinuses.

This condition of teeth she had had, she said, for a year or more.

The tongue presented a moist, soft, flabby appearance.

The provisional diagnosis I made, after full consideration, was against it being cancer, and in favour of the gastric condition being due to continual swallowing of pus. The sickness she complained of appeared to be an utter loathing of food with nausea, rather than actual sickness, and these might be well accounted for by the quantity of pus she was constantly sucking into her mouth from the decayed stumps.

I directed her to have the stumps removed at once, preparatory to any further treatment.

She consented to this after some demur—(the stumps, she said, could not possibly be at fault, as they had been in that condition for a year or more—a period closely corresponding, it will be noted, to the duration of her illness)—had them removed the following day, and apparently with the most immediate and satisfactory result. For when she reported herself a week later, she had had only one return of sickness and gastric pain, viz., the day after the extraction; had lost all bad taste in mouth; was able to taste her food for the first time for months; the tongue now quite clean.

This striking improvement, however, did not last. Three days later the gastric pain, with sickness and vomiting, recurred, and continued on and off for the next two weeks. A specimen of the vomit was obtained at this time, *i.e.*, three weeks after the extraction of the teeth; it was of a somewhat brown colour, with rusty, and here and there redder, streaks, and small flakes resembling bits of grape-skin.

On examination I found these flakes to consist of fibrinous exudation, with numerous leucocytes and crowds of streptococcus organisms, along with bacilli and cocci in much smaller number.

As it was now three weeks since the suppuration in the gums had been stopped, I regarded the presence of these organisms as confirming my original suspicion, viz., that the case was one of sub-acute infective gastritis or sub-acute infective catarrh.

Up to this time the patient had been struggling to get about, but she was now too ill to do so.

The subsequent course of the case was as follows:—I confined her to her bed for eleven days, fed her entirely on peptonised milk and gruel, beginning with one-and-a-half pints daily, applied counter irritation to stomach with sedatives internally; and, specially to combat the streptococcal infection, gave salicylic acid in 3 gr. doses, thrice daily after food.

The improvement was immediate and continuous. The sickness and pain were entirely checked from the first day, the tongue lost its raw, angry look, and became normal. The pulse fell from 102 to 80 and 70. Temperature normal (which had been 99°). In ten days' time she was able to go out driving and to return home to the West of England. I kept her on peptonised milk and gruel for another month, at the end of which time she reported herself as still without return of pain. A month later she reported herself still free from any pain, and gaining in weight, although still on milk diet. It is now five months since her illness, and she has no recurrence of any stomach trouble.

Cases of this kind could, I have no doubt, be paralleled by many others in the experience of Members of the Society. One almost identical is recorded by Miller (p. 298). A lady aged 45, complained for months of severe pains caused by eating, loss of appetite, indigestion, &c.—her troubles so great that she declared life had become insupportable. She showed two envelopes filled with prescriptions both for internal and external use. A glance into her mouth, its fœtid odour, and the inflammation and suppuration of gums suggested at once the cause. The

cleansing of the mouth and the use of antiseptic and astringent mouth-washes caused such a pronounced improvement in a fortnight that the patient could not often enough express her thanks.

In this case, he adds, the source of the trouble was so apparent he could not understand why it had not been discovered before. And it is with reference to the constant overlooking of such class of cases that he elsewhere brings the charge against many physicians, that "the custom to disregard dental diseases altogether as a factor in pathology, is as unjust to their patients as it is discreditable to their profession. No physician can afford to be without a thorough knowledge of the pathological processes occurring in the human mouth, and their relation to general diseases."

*Infection from the Mouth as a Cause of Infective Gastritis.*

While resembling, however, many others of a like kind, the case I have recorded presents some special points of interest—in respect, namely, of the actual proof of infection of the stomach by streptococcal organisms, viz., the presence of pus, fibrin and leucocytes and numerous pus organisms three weeks after removal of source of the infection.

That organisms play a pathogenic *rôle* in

stomach troubles by setting up fermentative troubles is fully recognised.

Most writers on the subject would appear to regard this as the only way in which gastric disorders may arise from organismal infection. The case I have recorded would appear to suggest in certain cases another and even more intimate connection between gastric disorder and organismal invasion, viz., by an actual infection of the mucosa, and the setting up of, at first catarrh, and subsequently of more permanent inflammatory changes in the mucosa and submucosa.

The liability to such infection will be the greater if the organisms introduced be the recognised pyogenic organisms setting up inflammation and suppuration elsewhere.

Now the number of organisms that enter the stomach with the food and from the mouth is very large, and a very considerable proportion of these are permanently to be found in the stomach contents. Out of twenty-five kinds of bacteria found by Miller in the human mouth, eight were found in the stomach contents.

Moreover, the old view that organisms entering by the stomach were destroyed by the gastric juice has had to be abandoned in the light of the observations of Macfadyen and others.

Only a certain proportion are destroyed.

From Miller's experiments the conclusion is warranted that all bacteria swallowed at the beginning of a meal may pass alive into the intestine (in the fæces he found twelve of the twenty-five mouth organisms). It is only when the acidity of the gastric juice is considerable—say an hour or two after meals—that it exercises any direct bactericidal action.

"If we furthermore take into consideration the various and numerous affections in which the quantity of gastric juice, its percentage of HCl, is abnormally small, it will appear as though the stomach can afford almost no protection whatever against the passage of pathogenic micro-organisms through into the intestinal canal," or indeed, under favourable conditions to their sojourn in the stomach itself.

If, in addition to diminished acidity, we have also increased supply of pathogenic organisms, and moreover, the conditions be such that these organisms reach the stomach not only with food, but at all times, in the intervals between digestion as well as when food is taken, we have, I consider, pre-eminently favourable conditions for not only a temporary sojourn, but for possibly a permanent infection.

Such are the conditions typically presented in many cases of dental disease, viz., long-standing suppurating conditions around teeth and gums,

constant swallowing of pyogenic organisms, impaired digestion with diminished acidity.

That under such circumstances increased fermentations go on we know.

What, however, is not recognised, what certainly I never realised till I made the observations just described, is that there may be not only increase of the fermentative processes, but also what is more dangerous, that organisms with well-defined pathogenic properties may become, so to speak, permanently established in the stomach.

The mucosa of the stomach remains permanently exposed to infection from pyogenic organisms, and may in time become actually infected with them.

The subacute and chronic catarrh so often met with in association with suppurative dental disease may thus be, as in the case I have recorded, of infective origin, not merely the result of irritation set up by fermentation of food products, but the result of definite invasion of the mucosa and submucosa.

Under certain circumstances it is conceivable that the effect might not stop short at catarrh, but, on the contrary, lead to subacute inflammatory changes, resulting, as all such changes in glandular organs do, viz., in atrophy of glandular cells and increase of fibrous tissue.

The condition termed *atrophy of the mucous membrane of the stomach*, so well studied by Dr. Samuel Fenwick, and the more acute inflammatory change occasionally met with and likened by him to *eczema of the stomach*, may thus be, and in my opinion probably are, the result of old-standing infections.

*Phlegmonous Gastritis.*

It is conceivable, further, that in a still rarer group of cases the infection might become an even more acute and generalised one.

Such a condition we have in the disease variously designated phlegmonous gastritis, mycotic gastritis, purulent inflammation of walls of stomach, submucous abscess, gastritis purulenta, suppurative gastritis, gastritis bacillaris, gastritis mycotica.

On this subject I can refer you to an admirably full account given in the *Edinburgh Hospital Reports* for 1896, by Dr. R. F. C. Leith.

It may be said that such a rare condition as phlegmonous gastritis can have little in common with such a comparatively common condition as that we are discussing, viz., subacute and chronic gastric catarrh.

One might equally well maintain that such severe and generalised conditions as pyæmia and ulcerative endocarditis, or such intense local

infections as acute osteomyelitis, cannot have the same underlying cause, viz., pyogenic organisms as the smallest furuncle, the slightest local erysipelatous attack, or lastly, as the suppurative process going on around a diseased tooth.

But, nevertheless, such is the case. The difference is not one of kind, but one of resistance and dose. If, as the above case would appear to show, some forms of subacute gastric conditions met with in association with suppurations around teeth may be due to infection of the mucosa by the pyogenic organisms swallowed, it may well be that from time to time the infection of the stomach wall may take on a specially virulent character. While the ordinary effect of infection underlying dental caries is to set up at most a slight local periostitis or a localised gum-boil, in certain cases the same condition may give rise to the most intense local suppurations or even give rise to general pyæmia.

In 6 out of the 52 cases of phlegmonous gastritis collected and tabulated by Dr. Leith, micro-organisms were actually found. "If the methods for detection of bacteria had been as well known as they now are, I have no doubt they would have been found in them all" (Leith).

In the case described by himself and in 3 of the above 6, the streptococcus was the chief organism present.

He draws attention to the parallelism betwixt phlegmonous gastritis and erysipelas, and notes that while we often cannot tell how or why an erysipelas arises, we never speak of it as being an obscure disease, whereas every author who has yet written upon phlegmonous gastritis has done so.

Leith thinks it may be looked upon as a severe form of erysipelas of the stomach.

Curiously enough, however—and this is the interesting point in relation to our subject to-night—in discussing the probable source of the infection in such cases, the various possibilities are considered to be two, viz., the disease may arise from the side of the *stomach* or from *the blood.*

As to the conditions which favour the determination of the streptococcus to the stomach, the relative importance of alcoholic excess, dietetic errors, and overloading of stomach, is considered. There is no suggestion that the source of infection might possibly be the mouth.

And yet one of the cases (No. 45), in which the symptoms came on six days after a tooth extraction and death ensued on the tenth day, might well have had such an origin.

Condition found: In stomach submucous, muscular and subserous coats infiltrated with pus; mucosa slightly hyperæmic; in mouth "the gums swollen, and showed purulent ulcers; alveoli

of jaw slightly splintered. Submaxillary glands swollen."

The relation of events in this case I should conceive to be: a diseased tooth with purulent ulcers around as focus of infection; extraction; further inflammation and necrosis; constant flow of pus organisms into stomach for six days (probably also for a long period *before* the tooth was extracted); acute infection of its walls; suppurative inflammation and death.

## Discussion.

Mr. Albert suggested that as there was so much to discuss in Dr. Hunter's admirable paper the whole discussion might be adjourned, as it was so late. It was impossible to do justice to the paper in fifteen minutes, which was really the only time left for discussion. He moved the adjournment of the discussion.

Mr. H. Lloyd Williams seconded the motion, and suggested that it should be left to the Secretary and Dr. Hunter to settle when it should come on.

The motion was carried.

The President thanked the members who had contributed casual communications, and Dr. Hunter for his most interesting paper, and adjourned the meeting to Monday, March 6th.

# Odontological Society of Great Britain.

## ORDINARY MONTHLY MEETING,

*March* 6, 1899.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

The SECRETARY read the Minutes of the last meeting, which were confirmed.

The following gentlemen were proposed as members of the Society :—As a resident member: Mr. WILLIAM JAMES MACDONALD, L.D.S.Eng. As non-resident members: Mr. GEORGE OWEN BETTS, L.D.S.Eng.; Mr. DOUGLAS EDWARD CAUSH, L.D.S.I.

The following gentlemen were balloted for and elected members of the Society :—As resident members: Mr. CARPENTER HARRIS, M.R.C.S., L.D.S.Eng., 112, Harley Street, W.; Mr. ROBERT H. MANNING, L.D.S.Eng., 26, Wimpole Street, W.; Mr. WALTER FLOYD, L.D.S.Eng., "Lulworth," Rushey Green, Catford, S.E. As non-resident members: Mr. ALLAN LINDSAY GOADBY, L.D.S.Eng., Sidmouth House, Reading; Mr. J. HARPER, L.R.C.P., M.R.C.S., L.D.S.Eng., Cape Town, S.A.

The LIBRARIAN reported that, in addition to the usual exchanges and periodicals, he had received a copy of "Papers on Dermatology," 2nd edition, by Dr. Mapother, and a volume of the *Proceedings of the Dutch Dental Society* for 1898.

## Casual Communications.

Mr. Ashley Barrett read the following communication on impacted mandibular third molars. He said: I must apologise to the Society for bringing before it so threadbare a subject as that of impacted lower third molars, but I do so in the hope that I may obtain the views of others concerning the best and speediest way of relieving patients. I have here a model which illustrates this condition.

The patient, aged 20, had suffered the usual symptoms for several weeks. The soft tissues at the back of the mouth were much congested, and pain had been so severe for some time as to require the frequent use of sedatives.

I think the interest of the case lies partly in the variety of the measures advised, as likely to give relief, by four practitioners, by whom the patient was seen.

The first maxillary right bicuspid and also the first maxillary right molar were absent. The second and third maxillary right molars were present, the latter biting down upon the gum behind the second mandibular right molar. In the mandible all teeth were present with the exception of the third molar, of which one cusp could just be detected deep down behind the second right molar.

The patient consulted A., who advised extraction of the third mandibular right molar with the aid of ether. This she was not willing to undergo, and further advice was sought.

It was then advised by B. to extract the second mandibular right molar, while by C. it was advised to dissect off from over the buried third molar a triangular flap of gum. The patient was then seen by D., whose opinion and treatment took this form.

It seemed that the removal of the third mandibular right molar, as proposed by A., was very difficult or even impossible, seeing that the tooth was tilted much forward, with its roots well beneath the base of the coronoid process. The use also of ether was to be avoided.

By removal of the second mandibular right molar, as proposed by B., it seemed that relief would eventually be

given, but the relief would not follow immediately upon the operation, and the sacrifice of a valuable tooth was to be deprecated.

By the removal of gum tissue as proposed by C. it seemed doubtful whether much good would come, since a granulating tissue would probably result and this would still remain liable to being constantly bruised between the maxillary and mandibular third molars. It was therefore advised by D. to remove the third maxillary right molar; this was done with the aid of gas, and immediate and permanent relief was given to the patient.

The extraction of this maxillary third molar seemed less likely to impair masticating power than if the second mandibular right molar had been removed; further, its removal was (as is usually the case with a maxillary third molar) a very easy task; and the trouble, which arose (as it usually does when an impacted mandibular third molar is the offender) from the bruising of gum tissue between the upper and lower teeth, bid fair to disappear with as much certainty after extraction of the upper offender as would have been the case had the lower been removed.

The result seems to have justified the treatment, and it is interesting to see that the models I now pass round (taken four weeks after the extraction) show that the mandibular third molar is rapidly erupting and assuming a more vertical position now that the bite of the third maxillary molar is removed.

If it should seem desirable to any members to criticise the treatment advised and adopted I shall feel greatly obliged and interested.

Mr. R. H. Woodhouse said one treatment suggested itself to him, and that was first of all to have taken off the sharp cusps of the maxillary third molar before removing the tooth. As a little trouble seemed to have arisen from the pressure on the lower gum, that might have relieved the irritation and so saved the tooth.

Mr. S. A. T. Coxon said that he had found the tooth that he mentioned at the last meeting, which he thought

he had in a collection left by his predecessor, and also the broken swivel. If the tooth were looked at, it would be found that a hole ran through it transversely, and it also had a platinum socket as an ordinary tube tooth. With the tooth he found also two other molars which he exhibited, and also exhibited some very hideous looking teeth, which, he thought must evidently have been used at one time. He also showed two bicuspids which he thought would be more or less interesting.

## *A Contribution to the Histological Study of Dentine.*

By F. T. Paul, F.R.C.S.

The object of the present research is to trace in detail the development of the matrix of hard non-vascular dentine.

The material used for the purpose was chiefly the tooth germs of man, ox, sheep and pig, and to a less extent those of monkey, dog, rat and cat.

Weak "Fleming" was employed for fixation, nitric acid and spirit for decalcification, Ehrlich's logwood, eosin, and dyes of the nature of nigrosin for staining.

The tooth pulp or dentine papilla of higher vertebrates in its earliest condition is represented by an aggregation of round nuclei, about which there is a small amount of clear protoplasm. The cells have no recognisable limit in the ordinary fixed and stained condition, so that the appearance is that of numerous round nuclei staining deeply immersed in a common protoplasmic pulp staining scarcely at all. At this

period the surface cells are in no way differentiated from the rest.

After a time the protoplasm belonging to each cell becomes recognisable, not so much from the presence of a cell wall, as owing to the development of short processes which become visible at the periphery. These processes are surrounded by a perfectly transparent medium, probably fluid during life, but gelatinised by fixation. There is still no differentiation of the surface layer.

The pulp cells continue to increase in size. Their nuclei become large and oval in shape and their protoplasmic processes become long and branched. They stain well and continue through subsequent stages to be one of the most noticeable features in the structure of the pulp. The ameloblasts are still short, but a commencing change in the surface of the pulp beneath them is foreshadowed by the appearance of a narrow border of translucent tissue in which there are no cells.

The tooth pulp is generally described as a mucous connective tissue consisting of branched cells surrounded by a transparent basis substance rendered somewhat granular by numerous cell processes seen in transverse section (figs. 1 and 1*a*). Fibres, apart from those in connection with the larger vessels and nerve bundles, are said not to exist, except in the form of cell

processes. This statement seems to me to be absolutely incorrect. The demonstration of a complete fibrous basis throughout the pulp is chiefly a question of staining. If a selective stain of the nature of nigrosin be thoroughly used, delicate wavy fibres interlacing in every

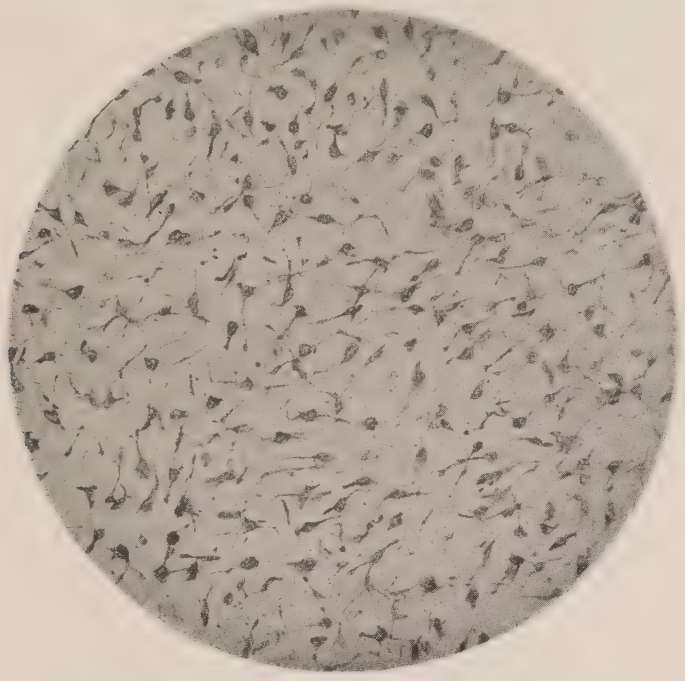

FIG. 1.—Section of young tooth pulp in which no special differential stains have been used. × 175.

direction are rendered visible. They are distinctly derived from the cells, and not from the intercellulur substance, and have the characters of very fine gelatin-yielding fibres (figs. 2 and 2*a*). The recognition of this fibrous evolution on the part of the pulp cells is essential for the appreciation of the subsequent developmental changes. When sections have been stained in such a

FIG. 2.—Section of young tooth pulp, stained to show full structure. × 175.

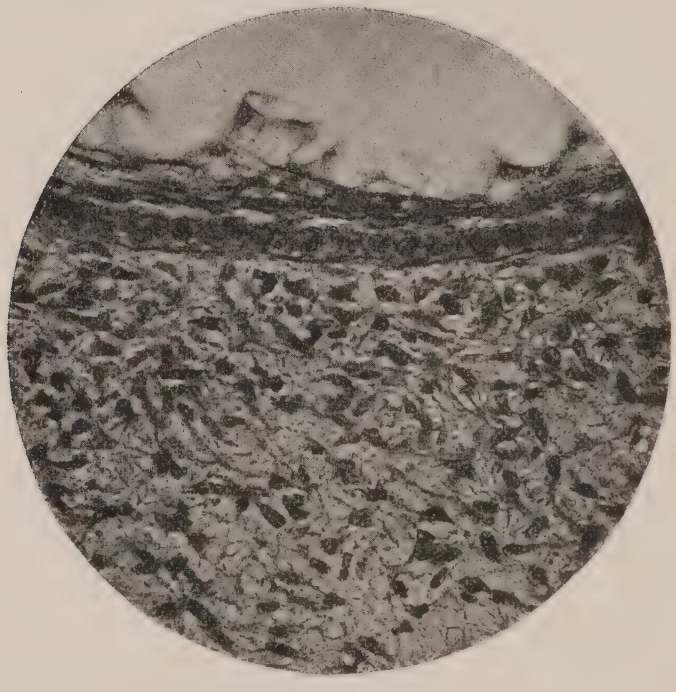

FIG. 3.—Section of tooth germ before surface cells of the pulp have undergone any differentiation. × 250.

manner as to show the fibrillar structure of the pulp, the clear border already mentioned as the first change effected in its surface is seen to be no longer apparently structureless, but is found to consist of innumerable delicate fibres radiating from the superficial pulp cells to the actual surface of the pulp. At first these superficial

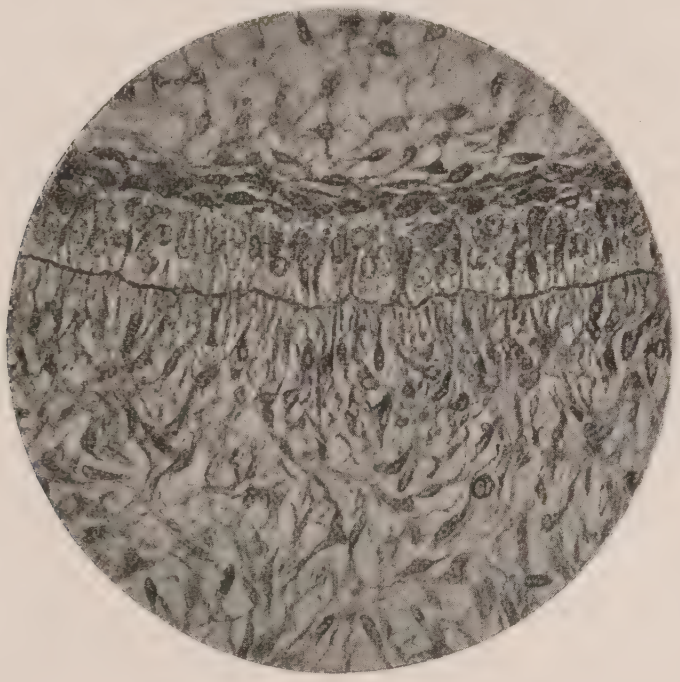

FIG. 4.—A later stage than fig. 3. Shows surface pulp cells becoming arranged in a fairly regular layer, with their chief processes directed towards the ameloblasts. × 250.

pulp cells are arranged in no definite order (figs. 3 and 3*a*). A little later in the process of development, and co-incidentally with the elongation of the super-imposed ameloblasts, they form a distinct layer and appear in vertical section as a fairly regular row, presenting numerous fibrous processes directed towards the surface (figs. 4 and 4*a*).

It is essential to recognise that these cells are not young odontoblasts, for which they have been uniformly mistaken, the error being due to the fact that in ordinary preparations the fibres they give off are invisible. They appear in such specimens to be set in a clear medium and present only one or two processes directed towards the surface. Tomes, describing odontoblasts before the formation of dentine has commenced, says : " To render my meaning more clear by a homely illustration, the surface of the pulp at this stage reminds one of the clear jellies put upon the table with strawberries, or the like, buried in them, near to, but beneath the surface."

When, however, a selective stain has been properly used, the clear jelly is found, as has been just previously stated, to be occupied by delicate fibrils, which are all derived from the surface layer of pulp cells ; in fact, these cells have already reached the climax of their development. Their nuclei are passing on to a resting stage, becoming small and narrow and showing less structure, whilst their fibres are increasing. Their object is not to become odontoblasts, but to produce the fibrous basis in which the first layer of dentine is deposited (figs. 5 and 5*a*).

In connection with this fibrous layer on the surface of the pulp, it is interesting to note a

recent contribution by Tomes upon the "Structure and Development of the Enamel of Elasmobranch Fishes," just published in the *Transactions of the Royal Society* for 1898. In several specimens he finds a "specialised layer" of tissue between the true odontoblast dentine and the enamel. This specialised layer previous to calcification is purely

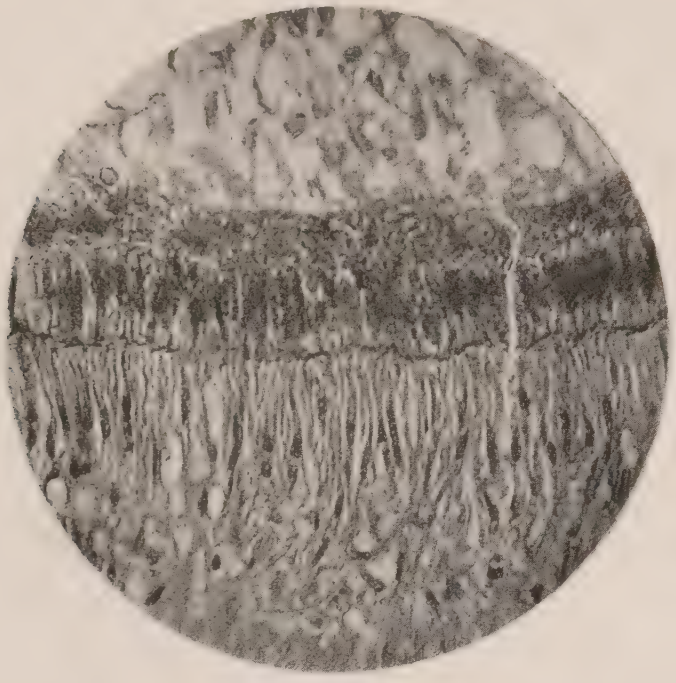

FIG. 5.—Shows complete evolution of surface pulp cells. They have produced a superficial fibrous layer, and their nuclei are now in a "resting" state. The odontoblasts have not yet appeared. × 250.

fibrous. It has a much greater depth than the layer we have been considering, but its general characters and relations are such as to make it probable that they are homologous. Since writing this I have, by the kindness of Mr. Tomes, been allowed to examine his original

specimens, and the examination has confirmed the above opinion.

The next step in the direction of calcification is the appearance of large oval nuclei at short distances from each other amongst the surface layer of pulp cells just described. These nuclei are the first recognisable condition of the odonto-

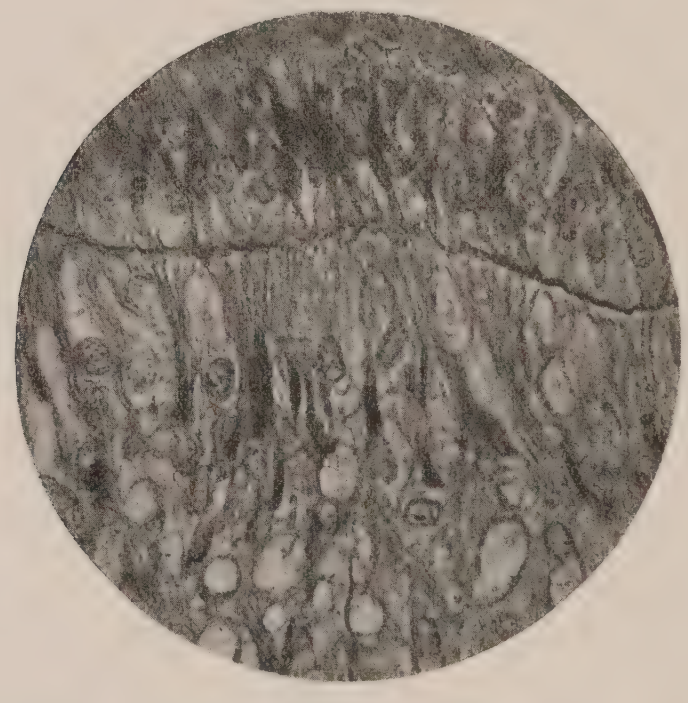

FIG. 6.—First appearance of odontoblasts, with their large oval nuclei amongst the superficial fibrillating cells shown in fig. 5. The nuclei of the latter have undergone further atrophy. × 500.

blasts (figs. 6 and 6*a*). As nuclei they are quite distinct from those of the surface pulp cells which are approaching a resting stage before the odontoblast nuclei appear, otherwise it would be impossible to distinguish the latter, for they have at first no visible protoplasm.

This substance seems to be quite clear and unstainable in the early stages of its development, but a little later it becomes granular and then takes up plasmic dyes. When about one quarter its normal size an odontoblast may be easily recognised. It then consists of a large oval nucleus situated at its extreme base, with a short pyramid of protoplasm reaching towards the surface and displacing the fibres of the surface pulp cells on either side. At this time it, of course, possesses no dentinal fibre, merely ending in a blunt point, though no doubt some delicate, invisible, protoplasmic processes are given off like the processes of osteoblasts, of whose presence we should be unaware but for the permanent canaliculi they leave in the calcified matrix.

Young odontoblasts have the appearance of rapidly-growing cells. One does not count a great many in passing from immature to fully-developed cells. They do not all extend quite to the surface of the pulp, as before attaining this point some become functional and secrete calcoglobulin, which is first deposited on those superficial pulp fibres amongst which they originated, that is to say, the first formed dentine matrix is as clearly and definitely laid down in pre-existing connective tissue fibres as is the case with bone matrix (figs. 7 and

7*a*). The osteogenetic fibres of bone are too well known to require more than a passing notice, but they also need a selective stain to show well their origin from connective tissue cells, their intimate anastomosis with adjacent connective tissue fibres, and their ultimate fibrillar structure. The only reason that osteo-

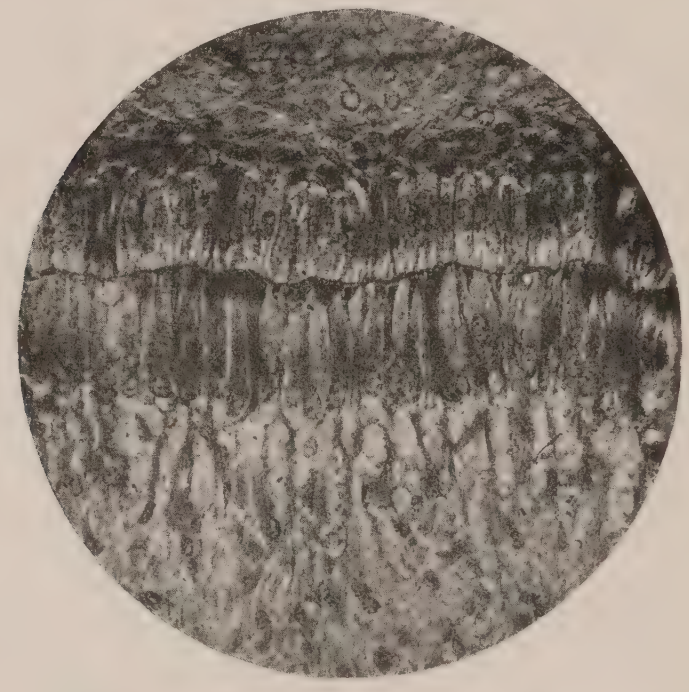

FIG. 7.—Shows further development of the odontoblasts and the first deposit of dentine matrix in the "basement" membrane, and the remains of superficial fibrillated cells. × 250.

genetic fibres are so well known, and their counterpart in dentine so difficult to recognise, is that in the former case they are derived from a coarse type of connective tissue, and in the latter from the infinitely more delicate pulp structures.

The penetrating fibres in dentine were first described by Mummery (figs. 8 and 8*a*). He thought that he recognised them throughout the formation of dentine, and his views as to the calcification of dentine are based upon this observation. The process employed by Mummery was von Koch's method of staining

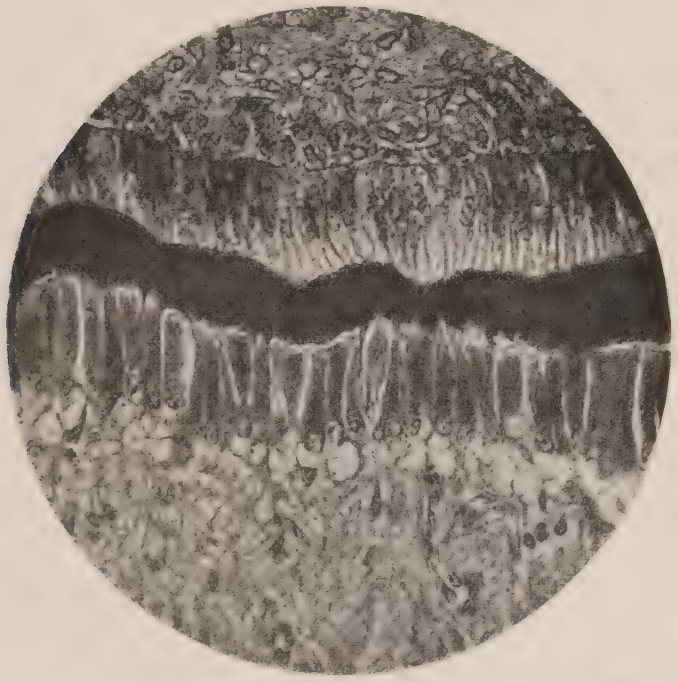

FIG. 8.—A later stage than fig. 7. The dentine matrix forms a definite layer, and the penetrating fibres are diminishing. Beneath the odontoblasts is the "Basal layer of Weil." × 250.

in bulk, penetrating with hardened balsam, and grinding down hard and soft tissues together. In my hands I have found it impossible to attain the delicate finish in staining and other details by this process, which would permit the intelligent and reliable use of high magnify-

## PLATE

To Illustrate Mr. Paul's Paper on the Histology of Dentine.

The tissues have been drawn under a magnifying power of 350 diameters. For perfectly accurate measurements and exact reproductions see the microphotographs. The lettering of the figures is the same throughout.

(*a*) Ameloblasts.
(*b*) Odontoblasts.
(*c*) Connective tissue cells of pulp.
(*d*) Connective tissue fibres of pulp.
(*e*) Basement membrane or transitional tissue.
(*f*) Dentine matrix.
(*g*) Penetrating fibres of the dentine.
(*h*) Blood vessel.

(1*a*) Connective tissue cells and their processes as seen in a young pulp, in the preparation of which special differential stains have not been used.

(2*a*) Connective tissue cells of a similar pulp stained to show their full structure.

(3*a*) The surface of the pulp before any differentiation in the cells has taken place.

(4*a*) The same at a later period. The surface cells are becoming arranged in a regular layer with their chief processes directed towards the ameloblasts.

(5*a*) The same still later. The surface cells are fully developed and have resulted in the formation of a definite superficial zone (*d*). Immediately beneath the ameloblasts the fibres blend to form a thin membrane (*e*). The nuclei of the surface layer are in a resting state.

(6*a*) The first appearance of odontoblasts (*b*) between the fibrous surface cells illustrated above. The latter are displaced and their nuclei undergoing further atrophy.

(7*a*) Growth of odontoblasts and first deposit of dentine matrix (*f*) in the fibres of the surface cells; their nuclei have now entirely disappeared.

(8*a*) Further development of dentine matrix (*f*). Up to this stage it consists almost entirely of penetrating fibres (*g*) resembling the osteogenetic fibres of periosteal bone.

(9*a*) Illustrating some characters of odontoblasts (several typical intervening odontoblasts are not represented). The first cell on the left shows two normal nuclei: the second two nuclei, the uppermost of which is degenerated; the third a single nucleus at the top of the cell placed transversely; the fourth a single typical nucleus; the fifth a typical nucleus, and one in the last stages of atrophy in the dentinal fibre. Round the necks of the odontoblasts is the transitional tissue (*e*) adhering to the cells, and in the centre is a blood-vessel (*h*) in the odontoblast layer.

(10*a*) Shows the transitional tissue (*e*) adhering to the dentine matrix (*f*).

(11*a*) The odontoblasts are invested with a network of fibres derived from the connective tissue cells of the pulp (*d*) which terminate in the transitional tissue (*e*), a delicate fibrous membrane woven about the necks of the odontoblasts.


Fig. 1a.

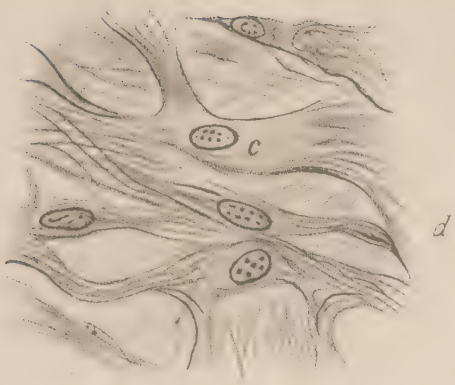


Fig. 2a.

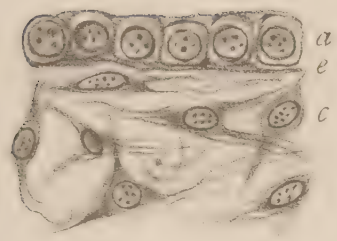


Fig. 3a.

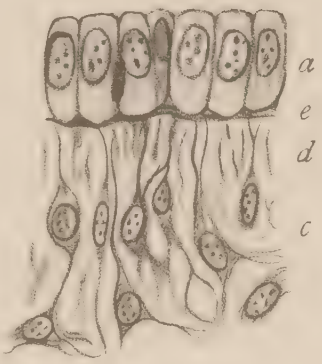


Fig. 4a.

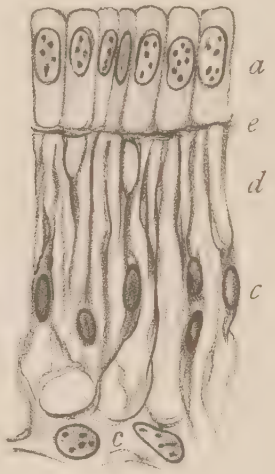


Fig. 5a.

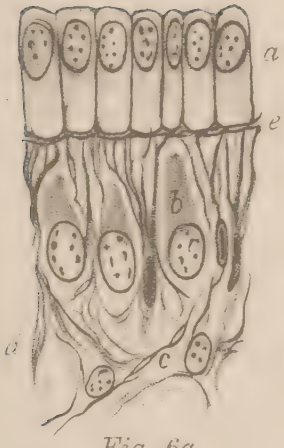


Fig. 6a.

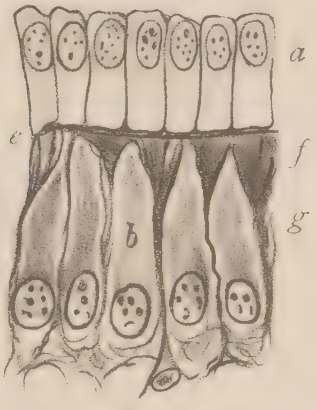


Fig. 7a.

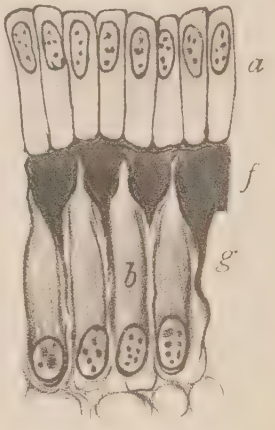


Fig. 8a.

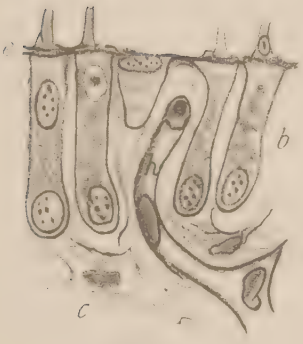


Fig. 9a.


Fig. 10a.

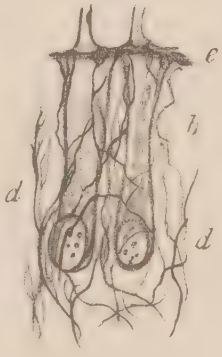


Fig. 11a.

Bale, Sons and Danielsson, Ltd., Lith.

ing powers. What I mean is that von Koch's method used for the solution of such a problem as this is to court errors in observation. The thinnest and most perfectly stained sections are essential in studying the changes which take place in the development of dentine matrix. My own observations all tend to show, and I think conclusively, that penetrating fibres play but a small part in the continuation of the process. The development of dentine matrix has been very correctly compared by Mummery with the development of bone matrix; but one must be careful to compare relative stages in the processes. Bone and dentine are each first laid down in fibres relatively coarse as regards the continuation of the process, and the later formation of dentine matrix, which is a building-in of the tooth pulp, should not be compared with the out-growth of bone in periosteum, but with the subsequent building-in of the Haversian systems.

Before leaving the pulp surface I will just call attention to two further points connected with the initial stage of the development of dentine matrix. The first is to notice that, when the radiating fibres derived from the surface layer reach the ameloblasts, they join together to form a superficial layer or network presenting in section the appearance of a

basement membrane. This structure is the first substance to calcify, and I direct attention to it here as I shall have to make a subsequent reference to it (fig. 7).

The second appearance to be noted in this connection is a narrow clear zone of tissue just beneath the most actively growing young odontoblasts. This has been called the " basal layer of Weil." It seems to me, after many careful examinations, that the appearance is not due to the presence of a specialised tissue, but is simply owing to a rarefaction of the pulp preceding the active extension of the odontoblasts, which are of course progressing inwards through the pulp matrix (fig. 8).

I now proceed to discuss the process by which the dentine matrix is formed after its commencement in the superficial pulp fibres. When the matrix has attained a depth of about $\frac{1}{500}$th of an inch, the penetrating fibres of which at first it was entirely composed begin to shrink and disappear, and though they may be met with perhaps at all stages of development they cease to take any important part in the process. An examination of the odontoblast region shows now the following appearances. First the odontoblasts themselves are very long, in the ox they frequently attain the height of $\frac{1}{500}$th inch, but remain narrow, about $\frac{1}{3500}$ inch. Towards the pulp they

are somewhat irregular as to level, but towards the dentine they are exactly in line. Each cell terminates towards its periphery in a single dentinal fibre which enters the matrix. The nucleus continues large and oval, with a bright reticular structure. It is generally situated at the bottom of the cell, as at an earlier stage. Sometimes the nucleus is in the middle part of the cell, and occasionally it is quite at the top, where its final position seems to be with its long axis across the cell. When the nucleus has been observed at the top of the cell the latter has been short, or has been cut obliquely so as to appear short. At any rate this is a condition which leads one to assume that the odontoblast under observation is exhausted, and probably it has ceased to grow and will unite with a more vigorous neighbour, which will in future continue the trunk of the dentinal fibre resulting from their union (fig. 9*a*).

It is of course evident that odontoblasts must lessen in number as the building-in process progresses, and I have often observed what appeared to me to be two cells which had coalesced, but not so distinctly as to be quite certain that the observation was not fallacious. However, apart from the evidence afforded by the union of dentinal tubules as seen in the ordinary ground sections, there are other circum-

stances which point in the same direction. One of these is certainly the presence of two nuclei in the same cell, a condition by no means uncommon. They are never close together, one as usual being at the extreme base, the other somewhere near the top. One sees none of those nuclear changes which accompany mitosis, and it is therefore difficult to understand the presence of a second nucleus except on the theory that it has been derived from another cell. A strong corroboration of this view is found in the fact that in some instances the second (or upper) nucleus is in a condition of degeneration and atrophy, which would not be the case had it originated as the result of reproductive processes. Sometimes one may even see well-marked and unmistakable remains of the atrophic nucleus in the dentinal fibre, so well marked indeed as to be clearly visible in a photograph, which seems to me to be the strongest indication that exhaustion and reinforcement have taken place (fig. 9*a*).

The lower four-fifths or so of the protoplasm of an odontoblast is very granular, but the upper part is generally more clear and homogeneous, and does not stain so deeply; it seems to have attained a stage nearer the composition of calcoglobulin. The granularity in cross section is seen to consist in either a very coarse deeply staining reticular structure, or the presence of

numerous globules of a clear substance, query calcoglobulin, in its earliest stage of formation. Osteoblasts usually present the same appearance. At the border line between an odontoblast and the dentine matrix, but nearly always adhering to the former, each cell presents an appearance as though it possessed a shoulder or collar

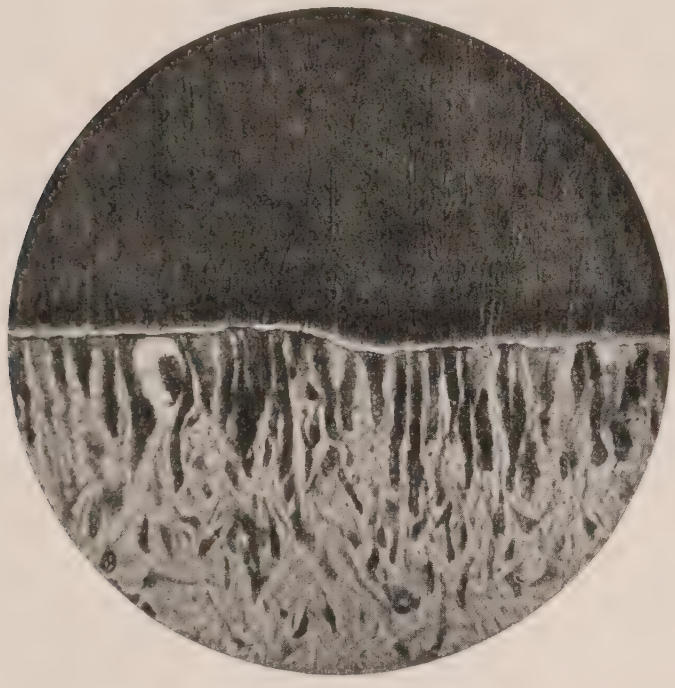

FIG. 9.—Shows the line of transitional tissue along the top of the odontoblasts; at one place it stretches across a gap between two cells caused by the intervention of a blood vessel undergoing degeneration. × 250.

differing in several features from the rest of its structure (figs. 9 and 9*a*). In the first place the presence of this collar cannot be passed over, for it shows up quite distinctly. It takes the stain rather deeply, it is more highly refractile than any

other part of the cell, and is the only part in which the cells are in contact with each other. They cling together in this region even when some accidental circumstance causes them to separate widely below. This shoulder, or collar, seems to be a transitional stage between formed and unformed matrix, and if so is of the utmost importance in tracing the process. I shall return to a further consideration of its nature after describing the remaining features of the odontoblasts. I have never been able to satisfy myself that odontoblasts give off more than one process, the dentinal fibre. Either this is the only process, or they are more or less everywhere in communication with pulp fibres. Both appearances and probabilities are against the latter view, as they are against similar connections with osteoblasts. Around the bases of all odontoblasts are numerous fibres which cling to them and are readily mistaken for processes, but which really belong to the pulp matrix. If odontoblasts give off such processes they would be protoplasmic, and ought to be at least as easily seen as those of the deeper pulp cells. I am inclined to the opinion that they do not give off either lateral or deep processes.

Odontoblasts only touch each other in the collar region (figs. 9 and 10). This point has been variously stated, but there are very good

reasons for putting it definitely as above. If the section is not very thin, overlapping odontoblasts seem to form a continuous layer as drawn by most authorities; but in very thin sections, when selective stains have been well used, not only are the odontoblasts well removed from each other—except at the collar—but the

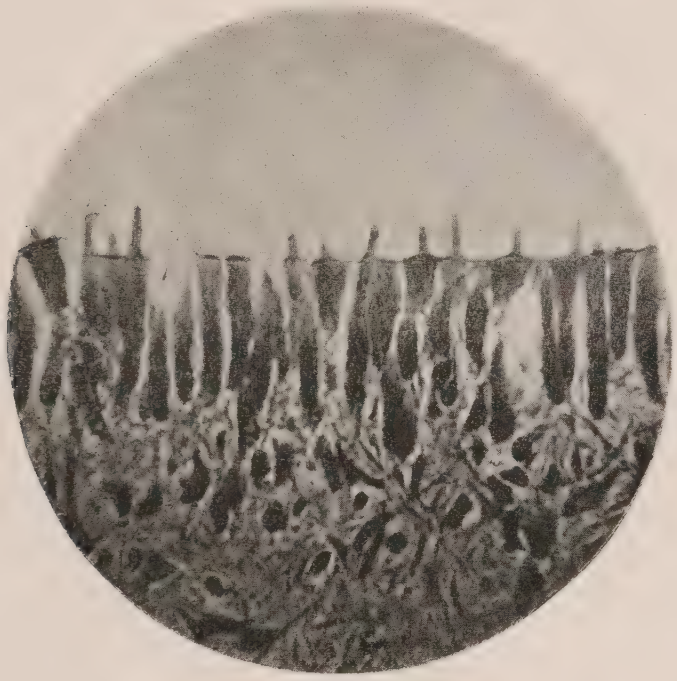

FIG. 10.—A very thin section of odontoblasts, showing the pulp fibres investing them, and ending in the transitional tissue forming the shoulder or collar of each cell. × 340.

pulp matrix is traced in between them as very delicate interlacing fibres by which they become thoroughly invested. If one had any difficulty in tracing the pulp matrix amongst the odontoblasts its presence would be proved all the same by the frequent appearance of blood vessels

between them, the larger of which do not disappear until they are almost in contact with the dentine matrix (fig. 9*a*). I do not remember to have seen this fact referred to, but in any very thin and well stained section blood vessels may be seen amongst the odontoblasts, and nothing proves more surely that these cells insinuate themselves amongst the pulp tissues, rather than advance as a solid phalanx removing all pulp structures before them.

In life there can be no doubt that the odontoblasts are in direct contact, or one might say in direct continuity, with the dentine matrix. In our preparations the collars of the cells have separated from the matrix whilst the dentinal fibres remain in contact, but not in continuity, if, as I think, they are merely traversing tubules in the matrix. I have referred to the distinctive characters of the collars, and it is quite easy to see that the separation almost invariably takes place between them and the matrix. Occasionally, however, the collars remain in contact with the matrix, a point of some importance, as I shall endeavour to show that they do not belong to the cells at all, an opinion which is certainly strengthened when we find that they do not invariably adhere to the cells (fig. 10*a*). Traced from above then odontoblasts are usually seen to have separated from the dentine matrix along the

line formed by their peculiar collars, which are perforated by the dentinal fibres, less brittle structures frequently maintaining their continuity though evidently put considerably on the stretch. Traced from below we find the odontoblasts embedded in a delicately fibrillar pulp matrix which seems to adhere to them. The fibrils can be traced upwards between the odontoblasts, and though generally they gradually become less distinct and are ultimately lost sight of in the collar region, they may often be distinctly seen to end in the collar itself (figs. 10 and 11*a*). I am persuaded that a true interpretation of the cell collar is the crux of the whole process. It is evidently the transitional condition between soft tissue and hard matrix. It is the point at which soft tissue and hard matrix are in contact during life, and though in process of preparation the collar almost invariably comes away with the cell it may remain in connection with the matrix. It is the only point at which the odontoblasts are, or appear to be, in contact with each other, elsewhere they are separated by pulp matrix, the fibres of which are lost in this region. Now does this transitional tissue belong to the cell or to the pulp matrix? At first sight it certainly appears to belong to the cell, and if so, then notwithstanding that the first layer of dentine matrix is unquestionably

laid down like bone in pre-existing connective tissue fibres, the conversion view is substantially correct, and we must assume that the product of the odontoblasts first fibrillates, then hardens in the form of calcoglobulin, and finally calcifies. If on the other hand, which seems to me undoubtedly the case, the fibres of the pulp matrix unite together around the necks of the odontoblasts, just as the radiating fibres of the first layer of pulp cells do to form a sort of basement membrane beneath the ameloblasts, then the transitional tissue is derived from the pulp matrix and not from the odontoblasts, and dentine matrix is a secretion by these cells upon a fibrous basis derived from the connective tissue cells of the pulp. In favour of the former view there seems to me to be but little evidence, except the fact that the cell collar looks as though it were a part of the cell. In favour of the latter view, that the collar is the transitional tissue between pulp and dentine matrix, there are at least the following points :—

(1) The first formed matrix in both bone and dentine can be clearly shown to be laid down upon a pre-existing fibrous basis, which makes it highly probable that the process is continued on the same lines.

(2) Odontoblasts are surrounded everywhere except at the collar by pulp matrix, the fibres of

which can be seen to end in the collar region, and often they may be distinctly traced into this structure, making it almost certain that the collar is a part of the pulp matrix.

(3) Whilst odontoblasts proper are not in contact, the collars are in continuity, and may be seen stretched over a wide breach between two cells such as is caused by the intervention of a rather large blood vessel.

(4) The original surface pulp fibrils blend into a membrane which lies on the top of the young odontoblasts before their dentinal fibres are developed. This membrane has very much the appearance in transverse section of a continuous sheet of collars. On the surface it looks like a membrane because it is in complete continuity and separates two layers of cells, ameloblasts and young odontoblasts. In the later process, it being perforated by every dentinal fibre, when the odontoblasts are separated a portion clings round the neck of each held there by the fibre, and thus appears to belong to the cell.

(5) The collars, though they usually adhere to the cell, do not always do so. Sometimes they adhere to the dentine matrix.

In my judgment the balance of evidence is very strongly in favour of the view that the transitional tissue is derived from the pulp matrix, that it corresponds with the membranous structure seen at

an earlier stage on the surface, and really consists of a delicate network of pulp fibrils woven about the necks of the odontoblasts upon which the secretion of the latter is poured and solidifies to form the dentine matrix.

Up to the present I have only described the appearance of developing dentine, as seen in sections in which the odontoblasts are cut in the direction of their long axes. For some reason it is much more difficult to obtain sufficiently thin transverse sections which show the odontoblasts in their normal relationship to the formed matrix; in fact I have only been able to obtain satisfactory preparations of this kind from the cusps of developing teeth near their apices. Such sections, in my judgment, entirely corroborate the views based upon the appearance of vertical sections.

A transverse section through the apex of an incisor or canine germ of a four to five months fœtus shows an external ring of ameloblasts with the honey-comb structure of the first formed enamel in contact with a broad ring of decalcified dentine matrix. Within the ring of dentine matrix is a central area of pulp consisting entirely—or almost entirely according to the level of the section—of odontoblasts seen in cross section. Towards the centre of this area the odontoblasts are cut across near their bases, and then, in concentric rings up to the ring of matrix, one sees them cut

at higher and higher levels, until, at the very edge of the matrix, the dentinal fibres alone are visible as small round dots. Thus, in such a preparation, one sees odontoblasts in cross section from their dentinal fibres to their bases. Studying these more in detail, and beginning again towards the centre of the section, one sees here that most of the odontoblasts are cut across in the region of the brightly stained nucleus; then passing outwards in the direction of the formed dentine there is a broad ring of odontoblasts which are cut through the rather darkly stained body of the cell; then, as one approaches nearer to the dentine, the cross sections of the cells are still of full breadth, but are very transparent, with frequently a clearly stained central dot. This is the upper part of the odontoblast, which I have already stated is clear and homogeneous compared with the granular body of the cell. The central dot is the dentinal fibre passing through this clear upper part of the cell, and taking a plasmic dye sometimes quite strongly. At the very margin of the matrix the cross sections of the cells become suddenly much smaller owing to the rapid tapering of the odontoblasts. Finally, actually within the margin of the dentine, one only sees the wide tubules cut across with the fibres *in situ*.

So much for the cells; now for the intercellular substance, which is of more importance in its

bearing upon the matter in hand. Beginning again towards the centre of the section, one always sees a quite distinct amount of pulpar connective tissue between the bases of the odontoblasts. Progressing outwards the intercellular trabeculæ are continued until ultimately they blend distinctly with the dentine matrix. One looks with the greatest interest for the transitional tissue as seen in cross section, and it is rather disappointing to find that it is very difficult to trace. One sees in the intercellular substance near the dentine matrix some irregular and imperfect rings of darker stained and more highly refractile matter, and it was only after tracing this matter in fortunate sections in which there was a gradual transition from longitudinally to cross cut cells, that I was able to decide this substance was what one recognised as the collars in ordinary vertical sections; but—and here is the important point—the substance in question is distinctly intercellular, and can be traced in one direction into the pulp and in the other into the dentine matrix. Hence, if this observation be correct, and it is a difficult one to demonstrate clearly, the transitional tissue would be proved to belong to the pulp and not to the odontoblast, when it necessarily follows that the process of dentine formation is one of secretion by the odontoblasts upon a fibrous basis derived from the pulp.

To complete the investigation I should like to refer a little more in detail to the development of bone. I have already stated that in my opinion bone and dentine are merely varieties of the same tissue, and that in all essentials they are similar. Also it may be distinctly shown that the first bone (membranous) and the first dentine matrix are laid down in connective tissue fibrils formed before either the osteoblasts or the odontoblasts were devoloped. As bone is developing in membrane, the preliminary osteogenetic fibres are so coarse that they are readily seen without any special staining, unlike the delicate penetrating fibres of dentine which require very careful staining and very thin sections to show them. But the development of bone matrix comes to resemble the development of dentine matrix even more closely in its later than in its initial stages. As I have previously remarked, relative stages alone must be compared, and though the very first layer of dentine matrix resembles periosteal bone, almost the whole of dentine formation is a building-in process, and corresponds only to the building-in of Haversian canals. The tooth pulp corresponds to the delicate connective tissue in the canals, not at all to the coarse periosteal structures, and the odontoblasts should be compared with the ring of osteoblasts at the periphery

of each canal, rather than with the osteoblastic layer of the periosteum in which the cells differ somewhat in details. When one examines a broad young Haversian canal in a section of developing bone prepared and stained in the manner I have described for a tooth germ, the resemblance to a tooth pulp is remarkable. In the centre is a blood vessel; surrounding this a few young connective tissue cells with large oval nuclei embedded in a complete matrix of the most delicate connective tissue fibrils. At the surface of the pulp filling the canal is its membrana eboris, consisting of large cells often cubical in shape, which lie surrounded by the delicate fibrillar matrix of the bone pulp. These cells have the same bright oval nucleus as the odontoblasts, the same coarsely granular protoplasm, and sometimes even a more highly refractile border towards the bone matrix to correspond with the transitional tissue of dentine about which I have said so much. Between the osteoblasts a few delicate penetrating fibres may be seen; but as in dentine they are quite insufficient to explain the fibrillar and intercellular nature of bone matrix. Finally, beneath the osteoblasts, as beneath the odontoblasts, one often sees the rarefied tissue which has been referred to as the "basal layer of Weil." Only in their smaller size, and in the substitution of

numerous delicate and practically invisible protoplasmic processes for the one large dentinal fibre, do osteoblasts essentially differ from odontoblasts.

In concluding these observations I should like to summarise the main points which have been under discussion.

(1) To obtain good results special fixatives, very thin and carefully decalcified sections, and differential stains must be employed.

(2) It can be shown that the intercellular substance of the pulp is filled with delicate fibres of the gelatin-yielding class, which are derived from the cells.

(3) The first layer of cells formed on the surface of the pulp beneath the ameloblasts are not odontoblasts, but develop into fibres, and on the actual surface these fibres blend together and form a membrane which lies just beneath the ameloblasts.

(4) The odontoblasts appear later between these surface pulp cells, after they have fibrillated and their nuclei have assumed the resting stage.

(5) The first formed dentine matrix is due to the secretion of young odontoblasts upon the fibres of the surface pulp cells, and has the general characters and much of the appearance of osteogenetic fibres.

(6) In the subsequent process the penetrating fibres almost disappear. This later stage is comparable with the building-in of Haversian canals, not with the periosteal outgrowth of bone.

(7) The odontoblasts are very long and rather narrow cells. The nucleus is usually situated near the lower end, but may be quite at the top; or there may be two nuclei, the uppermost being sometimes degenerated. The lower four-fifths of the cell substance is coarsely granular, the upper fifth is generally clearer and more homogeneous. Only one definite protoplasmic process can be discerned—the dentinal fibre, which in transverse and sometimes in longitudinal section appears as a distinct substance in the upper part of the cell.

(8) Between the odontoblasts there is always a layer of fibrillar tissue derived from the pulp matrix. Vessels are frequently to be seen in this intercellular tissue amongst the odontoblasts.

(9) At the upper margin of each odontoblast, where it is in contact with the dentine matrix, is a thin layer of transitional tissue. There are good reasons for believing that this structure does not belong to the odontoblasts, but is derived from the fibres of the pulp matrix passing up between them, and corresponds with the basement-like membrane derived from the original

surface pulp cells, and situated between the pulp and the ameloblasts.

(10) The process by which dentine matrix is formed after the initial stage is one of secretion by the odontoblasts upon this layer of pulp fibres investing the necks of the odontoblasts.

(11) In all essentials bone and dentine matrix are developed on similar lines.

(12) The conclusions arrived at are broadly the same as those proposed by Mummery, but the descriptive details relative to the various steps of the processes are entirely due to original work.

## Discussion.

Mr. Mummery said the paper was a very interesting one to him, because it was a corroboration of the connective tissue view of the formation of dentine that was promulgated by Professor von Ebner, of Vienna, and by himself in 1891. Mr. Paul criticised the methods which he (Mr. Mummery) employed, and said he did not think the Weil method was sufficiently delicate to show the fine fibrils which had been thrown on the screen. He thought, if Mr. Paul had looked at his specimens first, it would have been seen that the very same fibrils between the odontoblast cells and surrounding them like a network, were distinctly shown, as they certainly were in the beautiful slides shown by Mr. Paul, and he thought the members present who saw the specimens would remember that the fibres did correspond with those demonstrated by Mr. Paul. The specimens were thin enough to be examined with a twelfth or sixteenth. He did not confine himself to the Weil process entirely, but made decalcified sections in other ways. He certainly traced the final fibres into the last formed layer of dentine. He did not quite understand the distinction which Mr. Paul made between the penetrating fibres and the fine fibres. His (Mr. Mummery's) argument in his paper was that the dentine was deposited in a fine connective tissue stroma derived from the pulp. With regard to the comparison with bone formation, Professor von Ebner drew attention to that some time ago, having written a paper about 1885, comparing the structure of dentine and bone. With regard to the blood vessels in the layer of odontoblasts, there was no doubt that blood vessels were continually seen among the odontoblasts, and he had shown

on the screen specimens where the blood vessels were seen to be close up to the dentine, and Mr. Mummery quite agreed with Mr. Paul that this was a usual condition.

Mr. Tomes thought all the members would agree that the paper added a very material number of facts to their knowledge of dentine formation. It confirmed in the main Mr. Mummery's idea, that in dentine formation a prior formation of connective tissue could be traced, and that it was in that connective tissue that the dentine matrix originated. It brought out some differences, and one feature of the paper which was absolutely new to him—he did not think he had ever met with anything touching on that ground before—was the early origin of a fibrillated layer before the odontoblasts appeared, which they did independently of it. Mr Paul had shown how the odontoblasts grew in the midst of that layer without obliterating it fully, but insinuating themselves, as it were, between its fibres, which fibres embraced in a sort of network each odontoblast cell. There was one point in Mr. Paul's paper in which he did not quite follow him, viz., he appeared to draw a very marked distinction between the formation of the earliest layers of dentine which were formed in the inter-odontoblastic tissue, if he might use the expression, and, in fact, before the odontoblasts were fully formed, and the later formation of the dentine matrix. It appeared to him, following the paper as well as he could, that the process was essentially one and the same. Mr. Paul contended all through that the dentine matrix was formed by the fibrillæ and connective tissue which existed between the odontoblasts, and he emphasised first and last that it was not the odontoblasts that formed the matrix, but the tissue which lay between them. Therefore he failed to follow Mr. Paul when he drew a distinction between the first formation of dentine matrix and the later formation. It appeared to him that the arguments brought forward and the specimens shown proved rather that it was essentially one and the same process from first to last. That appeared to him to be very much more probable, because they knew of no definite structural

differences, no chemical differences, between the outermost layers of dentine and those which lay deeper in, except only that the dentinal tubes did not exist in the outermost layer of the dentine, and could not exist there, because the odontoblasts were not yet formed; and whatever else the odontoblasts did they certainly did furnish the dentinal fibrils and kept open the holes in the dentine. He wished to show a few photographs of a different sort of dentine formation. They were very bad slides, because he had not had time to intensify the negatives, which were rather weak. If a dentine were taken in which there were no dentinal tubes whatever, a vaso-dentine such as that of a Hake, it would be found that in some respects there was just the same sort of thing that Mr. Paul had described. The second slide showed the pulp, the ameloblast layer and the surface cells of the pulp prior to dentine formation, which, according to Mr. Paul, were not odontoblasts, and were not going to be odontoblasts, but it might be plainly seen here and there that they were prolonged out into fibrils very much like the earlier photographs shown by Mr. Paul. The third slide was a specimen of dentine pulp showing the surface layer of the pulp, and in the surface layer these long cells forming a very distinct layer which tapered out into processes. A little later these cells took on an appearance very much more like odontoblasts, except that on careful examination one found them broad and flattened. They were cells with nuclei, but with flat ribbon-shaped ends. The next slide showed a very different state of things. The fibrillar layer seen in the other photographs had grown to an enormous size. They were now fibrous bands in which no trace of a nucleus could be seen. Mr. Paul might say perhaps that the specimen showed only a coarser carrying out of the process he had described, and that the hake —which had no dentinal tubes and therefore no true odontoblasts—had not got odontoblasts, but that its whole dentine formation was accomplished by the fibrillar cells which, from Mr. Paul's description, ante-dated the odontoblasts. He was not prepared very positively to pledge himself about it, because it was not fully worked out.

Mr. Hopewell-Smith said there were one or two things he should like to have had cleared up. In some sections of fully-completed dentine and fully-completed pulps that he had in his possession, at the apical region of the pulp he had come across, in several instances, non-tubular dentine. There was a short space where no odontoblasts existed and no tubules, and then a space with an odontoblast and its corresponding tubule. He should like to know how the matrix was produced in that instance? Why should not the odontoblasts be present in that particular part? Another thing he could not understand was how the question of pain was to be considered if the theory were accepted that the matrix of dentine was formed by the odontoblasts. It was believed that the dentinal fibrils were very sensitive, and he could not see himself how the odontoblasts could be considered to be secretors of matrix if the fibrils were very sensitive. He should like to know more about the terminations of the sensory nerves. It was a very difficult thing to investigate the matter, and his attempts previously had failed. There were two or three other questions he would like to ask Mr. Paul. What were the stains which he used for showing the blood vessels in the odontoblast region, which was so beautifully exhibited in the specimens under the microscope, and the method he had adopted for cutting the pulps *in situ?* He should like also to have heard a little more about Mr. Paul's opinion with regard to the nerve endings. Were the fibres that ran along the cells, as shown in the diagrams, arborisations of the nerve endings, or were they simply the connective tissue stroma fibres in the pulp?

Mr. F. J. Bennett said there was a paper by Dr. Rose bearing on the subject in the current number of the *Journal of the British Dental Association*, where the author figured and described what he considered to be two different forms of the odontoblast cells of the pulp, and pointed out that they were fibrillated, and much longer in size and narrower in the part where calcification had not taken place, and he considered that it depended largely

on whether the ameloblast layer was functional or not. Where it was not functional the long and narrow fibrillated cells appeared, whereas, where calcification had gone on typical odontoblasts were obtained. It was of interest in connection with Mr. Paul's paper, because it tallied very much with the description both of Mr. Mummery and Mr. Paul, and would represent the earliest possible stage of the pulp where reticular cells alone were seen. To Mr. Bennett, Mr. Paul's specimens, as specimens, were of far more value than any theory built upon them. That theory might be altered to-morrow, but the beautiful specimens which were shown would remain for ever.

Mr. Leon Williams said he should very much prefer to read the paper very carefully before expressing any critical opinions upon it, and if he were to say anything that evening, it would be largely in the way of compliment and congratulation. It seemed to him to be the most important paper that the Society had had on the formation of dentine, and coming after Mr. Mummery paper, and largely confirming it, it had, in addition, cleared up certain other points which had been very obscure. He thought the clearing up of those points had come almost entirely by the very superior *technique* of Mr. Paul's work. He had never seen such beautiful sections as had been shown under the microscope that evening, nor such photography as had been thrown on the screen. The paper raised a great many points that were extremely difficult to settle offhand. Although most of his work had been on enamel, he occasionally got a glimpse of dentine formation, and he had observed the fibres many times passing from beneath the odontoblasts into the forming dentine. He had also seen the appearances of nuclei in that end of the odontoblasts lying close to the dentine. In a paper published two or three years ago he showed such nuclei appearance in a dentinal fibre which had been *drawn out of the dentine*. He also saw in the paper a confirmation of a matter which he mentioned several years ago, but which was very emphatically disputed at the time, and that was, a fibrillated membrane lying between the ameloblasts and

the odontoblasts at the first stage of dentine formation. He was not quite clear about the disposal of the odontoblasts. Whether an odontoblast continued forming dentine from the time it was first developed was a point he did not feel at all certain about. It seemed to him that he had often seen the appearance of a breaking-down of odontoblasts directly in the dentine. He had also seen the appearance of the cells in it. He had some specimens which seemed to him to show so clearly the breaking-down of the substance of the cell of the odontoblast into the forming dentine, or the melting of the cell into the developing dentine, that he intended to go into the matter very carefully before expressing any critical opinions on the point.

Mr. Storer Bennett said the Society was decidedly to be congratulated on having had a most interesting paper, and seeing such charming photographs and such delightful specimens as Mr. Paul had shown. His only source of regret was that they were not placed in the adjoining room earlier, so that those members who had a few minutes to spare before the meeting might have had an opportunity of examining them. But one of the chief reasons for congratulation was, that the paper in a large measure confirmed the investigations which Mr. Mummery placed before the Society in 1891. It seemed to him that the greatest point made by the author, that of the fibrillar structure that formed the matrix surrounding the odontoblast, showing a sort of connective tissue basis on which the formation of dentine took place, was the very one on which Mr. Mummery laid so much stress something like eight years ago.

Mr. Kenneth Goadby said there was one question Mr. Paul had omitted from his admirable paper—he had made no reference to the Neumann sheaths. He asked Mr. Paul whether he believed in the existence of those sheaths? If not, of course the matter was pretty simple. But supposing those sheaths did exist, he should like to know from what part of the reticulated basement membrane or fibrillar basement membrane the sheaths were formed. Personally,

he had found that the Neumann sheaths had a distinct chemical composition, apart from the general matrix of the dentine. With regard to the question of calcoglobulin, of course the product obtained in the laboratory from such a tissue was a very different thing from the product in the natural state. But in the matter of investigating products obtained from dentine, one was unable to procure any appreciable amount of a substance such as albumen and globulin. Of course it might be that some change took place between the albumen and the calcium salt. Hopkins and Pinkus last year, in *The Journal of Physiology*, had shown that bromine, &c., formed compounds with albumen that retained their distinct chemical relation, and they could be isolated quite easily, and their general reactions studied. It might be that the question of calcoglobulin, so-called, was a matter more of that description. He could not say definitely, but it seemed to him, from recent work, there was some similar relations between the formation of such general matrices as bone and dentine and that curious condition of the combination of albumen as aforesaid.

Mr. Paul, in reply, said that the discussion tended to show what a great deal there was to be said about every new point raised. He had been asked numerous questions in reference to his small piece of work, which were really more or less outside its limits, and showed one what a great deal more there was to be done in regard to dentine than anything he had attempted up to the present. Mr. Hopewell Smith had asked as to the nerve terminations, and whether any of the fibres described as investing the odontoblasts were connected with them. He did not know that he was prepared, on the strength of his present investigation, to answer Mr. Hopewell Smith's questions, nor some others that had been asked. When Mr. Smith came to the point and asked him about the stain he used and his method of cutting, he was perfectly capable of furnishing an answer. For fixation he generally employed weak "Fleming." The stains used for the sections were Ehrlich's logwood, eosin, and subsequently some dye of the nature of nigrosin. He was almost ashamed to own that the best

dye he was acquainted with for the purpose of staining fibres was Stephens' writing fluid. That was a dye which seemed to him to stain better than any of the long-named scientific dyes he had heard of. He very commonly used that ink, of the strength of 10 to 20 per cent., according to the depth of colour desired. The method of cutting adopted had been freezing. He did not adopt that because it was the best, but because it was the most convenient under the circumstances in which he had to work. Mr. Mummery very rightly told him that he had not seen his (Mr. Mummery's) specimens, and that perhaps it was not altogether right to criticise his work without first seeing them. He had not had the opportuuity of seeing them, and any criticism he had made was merely based on Mr. Mummery's paper. He did not think that there was very much criticism of his work, because, as other speakers had said, his (Mr. Paul's) seemed to practically corroborate Mr. Mummery's throughout. Mr. Mummery and Mr. Tomes made a point with regard to the line of demarcation he had drawn between the first process and the subsequent process of dentine formation. He thought the reason perhaps that this was accentuated so much in his own mind was that without a very great deal of difficulty it became clear to him what the first process was; but when he tried to follow it out and trace the same change in the later process he found he could not do so, and it was a long while before he could understand the connection between the two processes. The reason was that in the first process on the surface one easily detected the penetrating fibres of Mummery passing between the odontoblasts and being connected with the pulp cells, whilst in the subsequent process a little bit lower down where there was a good bit of dentine formed one did not see anything of the penetrating fibres, and he gathered from Mr. Mummery's writings that the whole process of dentine formation was based upon the presence of these fibres. What he (Mr. Paul) found was that in place of true penetrating fibres between the odontoblasts there was a delicate network of pulp fibres investing them and ending in a continuous fibrous mem-

brane woven about their necks. Previously this membrane had been regarded as a part of the odontoblasts themselves, and hence the discrepancies between the observers as to whether dentine matrix was the result of secretion or conversion. The early and late processes, of course, were essentially similar, both being processes of secretion upon a fibrous basis. But still they were not altogether the same. In his own mind he was clear about the first process a long time before he understood the other, and therefore he had no doubt he had laid too much stress upon the fact that the processes were not exactly allied to each other. In regard to the presence of blood vessels in the odontoblast layer, he presumed many must have seen them because there were such a quantity of them there and they were so easy to see. He was very glad indeed to find from Mr. Tomes that he was obtaining results from an entirely different source, which suggested more or less corroboration of the work he had brought forward that evening. He quite thought that the superficial layer of fibres in his specimens really were homologous with the layer Mr. Tomes had demonstrated in some fish, and possibly the calcification of this layer was effected by the enamel cells in higher vertebrates as well as in fish and, if so, this fact would go far towards explaining the differences which had been pointed out between the early and later processes of dentine formation. Mr. Goadby had asked about the sheaths of Neumann. He considered there could be no doubt that the sheaths of Neumann existed, but he did not know that he was prepared to say the exact way in which they were formed. Presumably they would be formed on a slightly different plan from the rest of the matrix, because when the matrix was first formed the tubes were very widely open. They must, he thought, be made subsequently to the first formation of the dentine matrix on the fibrous issue. Mr. Leon Williams had spoken in a most appreciative manner. His sympathy with fellow workers showed as clearly as anything could do how patiently, earnestly and thoroughly his own investigations had been carried out. Finally, he thanked the members very much for

giving him the opportunity of bringing his paper before them and for the very kind and generous manner in which they had received it.

The PRESIDENT, having thanked Mr. Ashley Barrett and Mr. Coxon for their Casual Communications, and Mr. Paul for his very able paper, adjourned the meeting to April 10, when the adjourned discussion on Dr. Hunter's paper will take place.

# Odontological Society of Great Britain.

## ORDINARY MONTHLY MEETING,

*April* 10, 1899.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

The Minutes of the last meeting were read and confirmed.

The following gentlemen were balloted for and elected members of the Society :—As a resident member : CLARENCE H. KEALL, L.D.S.Eng., 31, Clarendon Road, Bayswater, W. As a non-resident member : SIDNEY HERBERT WILLIAMS, L.D.S.Eng., P.O. Box, 1218, Johannesburg, South Africa.

On behalf of Mr. Peyton Levason, the SECRETARY presented a model showing three fully erupted third molars in the mouth of a young girl aged 15.

Mr. H. W. MESSENGER presented an artificial denture, composed of tube teeth inserted into an ivory base.

### ADJOURNED DISCUSSION ON DR. HUNTER'S PAPER.

Mr. ALBERT thought that the Society was considerably indebted to Dr. Hunter for the care, the energy, the skill and the research displayed in his paper, and still more for having introduced to the Society one of the most important subjects that dentists, in common with physicians, had to treat. Dr. Hunter had wisely precluded discussion on one of the most important subjects which he had

mentioned, viz., the dental reflexes, and he hoped that on some future occasion Dr. Hunter would honour the Society by bringing forward the subject. He did not know that any criticism of the paper could be made. There was no doubt that all Dr. Hunter had said was indisputable, with perhaps the exception of the statements referring to the bacillus gangrænæ pulpæ, on which Dr. Hunter was more capable of forming an opinion upon. He knew that bacteriologists occasionally were wrong when they specialised. With regard to gastric sepsis he was very much interested in, and he thought sufficient importance had not been placed on a condition that was especially favourable to gastritis, viz., the condition known as mouth-breathing. He presumed from the tenour of Dr. Hunter's paper that the cause of gastritis in connection with teeth was apparently the swallowing of bacteria, and there must be other conditions of the mouth, apart from the teeth producing secondary septic conditions of the mouth, that would naturally predispose to gastritis. In hypertrophic rhinitis, post-nasal growths, or even in enlarged tonsils, nasal respiration was impossible. The researches of Dr. Sinclair Thompson showed that the upper pharynx was a practically sterile cavity, and in mouth-breathing it followed that the air in passing through the mouth was not sterilised, and he presumed, therefore, that mouth-breathing would produce infective gastritis, and generally infective diseases in much the same way as caries and necrosis of the teeth, even with the absence of the bacillus gangrænæ pulpæ. There were yet other causes producing it, superior protrusion or malocclusion, or some abnormalities in the formation of the upper lip, and he suggested to Dr. Hunter that there were numerous cases of gastritis connected with those varied conditions in which nasal breathing was impossible, and it was very interesting to see that the condition of the teeth in mouth-breathers was very often one of sepsis. The impossibility of keeping the teeth clean during the day and the drying of food on the labial surfaces of the upper teeth must necessarily predispose to general sepsis. He asked Dr. Hunter whether he could confirm those ideas

from any observation of his own, or quote a case with perfect teeth in which nasal breathing was impossible. It was difficult to limit one's belief in the connection of carious and necrosed teeth and what they might do. He had seen at least three cases of loss of memory completely relieved by the alteration of the conditions of the mouth. In another instance which had come under notice, a woman had for some months been treated for synovitis, which she herself attributed to a carious tooth. The tooth was removed, and a few days after all the synovial effusion disappeared, and never recurred. He asked Dr. Hunter if he could mention any relation between anæmia and septic teeth. There was also the point of the connection of rheumatism with teeth. He did not mean acute rheumatic fever accompanied by high temperature and endocarditis, but those cases of rheumatic pains not at all infrequent in connection with dental matters.

Mr. E. Lloyd-Williams felt that he could add but little likely to be of any service to the Society in the discussion, and therefore confined himself to one very small point. If he remembered rightly there was one case which Dr. Hunter brought out very fully, and the value of the case appeared to lie in the care with which the notes were taken. That was always true of all cases. One case very carefully taken might throw more light on a particular subject than a great number of cases loosely recorded. He thought it perhaps pointed to a condition of gastric irritation which existed far oftener than was supposed. It was commonly thought by the general practitioner that all dyspepsia which could not be cured by the ordinary prescriptions must be due to a bad set of teeth. In despair the medical man generally examined the patient's mouth, very often after a long, tedious treatment which had been of very little avail, and finding that there were several teeth absent, perhaps directed his patient to go and see his dentist. Very often in a large number of cases (especially in hospital practice) several roots were found with suppurative periostitis existing around them. Although those people had been suffering for a very long time from gastric irritation,

marked improvement often took place long before their artificial teeth were supplied, proving to his satisfaction that the gastric irritation had been very largely due to the septic condition of the mouth. He thought that was a matter which bore practically upon the every-day work of dentists, and if he might mention a purely dental subject, he felt there were still amongst them those who clung to the old idea that roots might be retained in the mouth with impunity. He ventured to think, however, in the light of what Dr. Hunter had told them, that they should be very careful in treating mouths of that sort, and if they were to err at all they should do so on the side of extracting all suspicious roots which might set up septic disease.

Mr. H. Lloyd Williams said that cases were frequently met with which amply confirmed the position that Dr. Hunter had taken up. Dr. Hunter had given the notes of one case, which was an extreme one, in which there was a very septic condition of the mouth followed by a very serious condition of the stomach. Clearly there must be earlier stages of that condition where patients were likely to suffer more or less trouble. He had recently had two cases which illustrated that point very clearly. One was in a young lady where there were no abscessed roots at all, but there were several very carious roots. She looked very much like a person suffering from cancer—she had that cachectic appearance, the appetite failed, and there were various other troubles. He extracted all the bad roots, and although she had a large number of carious teeth he considered she was not in a fit state to have anything more done. After the extraction of the roots she was ordered to the seaside, and came back in a month's time looking quite a different woman. He ascribed that entirely to the removal of the carious roots. In his second case there was some amount of suppuration around every tooth. Notwithstanding the fact of the patient having the teeth out without an anæsthetic, and considerable wounds being made in his mouth in that way, that man was rapidly recovering. When last seen, although he was absolutely edentulous, he said he felt quite a new man, and that his health had

improved wonderfully. He quoted those two cases to confirm from clinical experience the position Dr. Hunter had so ably demonstrated in his paper.

The PRESIDENT said there was no doubt that if the Society adopted Dr. Hunter's conclusions, all teeth with alveolar abscesses would have to be extracted, and that would considerably modify the conservative treatment generally pursued. His practical experience did not lead him to take such a very serious view of the presence of pus in the mouth. He thought where a large quantity of pus was developed in connection with the periosteum of the tooth, the general health was, as a rule, bad, and to blame for it. He had in his mind two cases which were remarkably striking at the time. They were both similar cases, both first mandibular molars, and both patients were Indian men worn out with life in India, with their digestions weakened. In one case the pulp was dead; he hardly remembered the condition of the other. In the one case, which he remembered very distinctly, the pus welled up by the side of the tooth in such quantities that he should imagine as much as twenty or thirty drops would be secreted during the twenty-four hours. The patient was a man of about 50, and had a mania for preserving his teeth. He (the President) treated the pulp canals for three or four weeks, but the pus showed very little signs of diminishing in quantity. The patient's brother, a Medical Officer of Health in London, said that the patient's digestion was in a terrible condition, and his idea was to starve him and treat him very much on the principle that Dr. Hunter seemed to have treated his Uxbridge patient. The patient, however, would not submit to the treatment, and subsequently called in Sir William Broadbent, who advised him to follow his brother's advice. He was put upon milk diet, and went to Scotland for perhaps two months; on his return he looked ten years younger, the tooth was absolutely firm, and the abscess was cured. The other case was very similar, and he could not have imagined that two such abscesses, with such a large amount of pus welling up by

the side of the tooth, would have cleared up simply with the improved condition of the health. Dr. Hunter did not mention in the Uxbridge case whether the same treatment that he recommended the patient to adopt had been tried before the extraction of the roots. The presence of three roots bathed in pus, underneath a plate of artificial teeth, alone would considerably interfere with perfect mastication, and thus affect the health and well-being of a patient. He did not think that Dr. Hunter had altogether proved that it was the pus from the roots that produced the gastritis.

Dr. Hunter, in reply, thought that the observations made by the members pretty well represented the condition of opinion with regard to the subject. The remarks of the President raised the question as to the relation of health to teeth as well as of teeth to health. The importance of *suppuration* and dead bone and the continuance of suppuration anywhere else in the body was recognised. If there were a small piece of necrosed bone in the tibia which suppurated for a year or two, the patient would be considered in rather an unhealthy condition. His feeling about it from the purely pathological view was that which Mr. E. Lloyd-Williams had given expression to. He did not wish that all teeth with suppurative periostitis should be removed; for frequently that condition could be cured and the tooth preserved. His lady patient was very averse to losing her three old roots, but he declined to have anything to do with the treatment until he got rid of the pus. Every time she swallowed she sucked down more pus, and it was easy to consider what a large quantity of pus she took into her stomach in twelve months. If one had, so to speak, applied one's mouth to a suppurating necrosed bone somewhere in the arm and sucked down the pus secreted there, he considered it would be an identical condition. On the other hand, suppuration from the teeth was not so important as elsewhere, because there was a most remarkable vitality about the mouth which probably exceeded anything in any other tissue of the body, so that there was a natural defence there against the extraordinary infections to which the mouth was liable. The matter of

*mouth infection* led him to reply to Mr. Albert's remarks on the importance of mouth-breathing. He had carefully avoided that subject as rather dealing with the mouth as a focus of infection. He endorsed most of what Mr. Albert had said, but the subject was rather wider than he wished to bring before the Society. In connection with febrile conditions he had always been exceedingly struck with the neglect of the mouth. The condition of sordes around the teeth and on the tongue was often regarded in febrile cases rather as an important symptomatic condition, than as one which it became an important part of treatment to get rid of, by appropriate mouth washes. With regard to whether the *gastric infection* was connected with septic condition of the mouth, he had brought forward one concrete case. He did not know that he should have ventured to touch upon the general subject, had he not had something which rather proved, as far as it could be done, the connection between the two conditions. One could only speak in general terms about a case where there was some stomach symptoms and there were decayed teeth, and the symptoms disappeared on removal of the teeth. The general importance of that subject was very fully recognised. He did not wish to lay much stress on the particular case which he had mentioned as exemplifying any special class of cases that existed; but regarded the case as a signal evidence of what might occur in other cases. If such infection occurred at all, it must occur in a milder degree in a very large number of cases where there was no possibility of confirming the diagnosis, as was done in this instance. Mr. H. Lloyd Williams' cases were very interesting, especially the one which showed that the removal of the teeth alone effected a cure. That rather proved that it was not merely the want of mastication, or anything of that kind, that had led to that cachectic appearance which those patients often present, but rather that they were suffering from chronic absorption of poisonous matter. It was a chronic septic condition, and when the cause was removed they underwent improvement at once. He had kept to the last the question asked by Mr. Albert as to the relation between *anæmia*

*and the teeth.* It formed the opening statement in his paper, and it was the subject which had been nearest his thoughts in connection with the matter. He had dwelt entirely on the relation of gastritis, but he had been for the last ten years collecting observations in his own private cases showing the connection between anæmia and the teeth. Mr. Albert asked whether the anæmia caused the carious teeth or whether the teeth caused the anæmia. His interest had been in the severest form of anæmia, pernicious anæmia, which embodied everything that was severe in connection with anæmic processes, which according to his observation was due to a chronic infection of some part of the gastro-intestinal tract; and the case which first roused his suspicion as to the possible *rôle* of the mouth ten years ago, was a man who had a curious condition of the mouth, a papular vesicular eruption which from time to time came inside his mouth and underneath the tongue. He complained of no stomach symptoms, but his condition was that of pernicious anæmia, of which he died. At the *post-mortem* he found a condition of subacute infective gastritis, a condition of inflammatory gastritis. The relation of the two was not clear, and he could not connect the two conditions except that the condition of the stomach seemed very much the condition of the mouth. Since then in various cases of pernicious anæmia he had had occasion to note remarkable conditions of the tooth decay. In one case, of a clergyman who had the profoundest anæmia, the mouth was full of necrotic teeth, and in a most extraordinary condition. Had he acted as he could have wished and the condition of the patient permitted so heroic a measure, he would have had every one of those teeth removed. Another similar case was a gentleman in London whom he was asked to see in consultation. He suffered from pernicious anæmia, and the teeth were in a similar condition to his first case. The condition observed in these cases was not merely the existence of one or more carious teeth, such as most people may have, but a curiously black necrotic condition which made one wonder why any person should keep them there

at all. He did not know now what the connection was, except that cases such as he had recorded rather led him to the conclusion that the teeth in those cases might possibly be a source of chronic poisoning, and that was a matter of extreme importance. If a man had a set of carious teeth in his mouth, he must be constantly absorbing poisonous matter, which, in time, must be very bad for him and might lead to secondary infection of the stomach. On the whole those were the facts which had led him to keep his attention fixed on the teeth, and he was exceedingly indebted to the Society for the opportunity of hearing their opinion upon the matter.

## *Notes upon Two Teeth which Present Unusual Diseased Conditions.*

By Charles S. Tomes, M.A., F.R.S., F.R.C.S.

The tooth which forms the subject of the present communication was sent to me by Mr. Riches, of Penarth, with the history that, although only in a moderate degree carious, it had resisted all treatment, and had become more and more loose and painful, till at last he was obliged to extract it.

He had previously had to extract other teeth from the same patient, which he now suspects may have been in similar condition, but unfortunately they were not preserved, and some of the remaining teeth are inclined to be painful. He feared that they might be lost in a similar way and so wished me to see the patient, a young lady enjoying fair health in other respects.

An examination of the mouth revealed very little; a few teeth were below the normal standard of firmness, and one in particular was tender in its socket; but as this was apparently

a dead tooth little could be inferred as to its condition.

The tooth sent to me at first glance did not present any very striking peculiarity; the crown was normal, and a moderate sized cavity, which had been filled, was present at the junction of the enamel with the cementum (fig. 2).

The crown was fairly normal in size and shape, while the roots were apparently fused

Fig. 1.

Fig. 2.

Fig. 1.—Mr. Riches' case. General view of the exterior of the tooth, showing the rugged, pitted character of the end of the root, with an excavation running a little way up on one side.

Fig. 2.—External view, showing the position of the carious cavity.

together, but in general outline were of a form that may often be found where the roots are connate; viewed from the side on which the cavity exists there is an appearance of two roots fused together by cementum.

The apex of the root, however, is coarsely pitted and a sort of excavation runs superficially a little way up one side (figs. 1 and 2); upon

making a median section through the tooth in its long axis it is at once apparent, even to the naked eye, that there is an altogether unusual condition present. The crown of the tooth as far down as the neck is perfectly normal and the pulp cavity is seen in section ; but below the

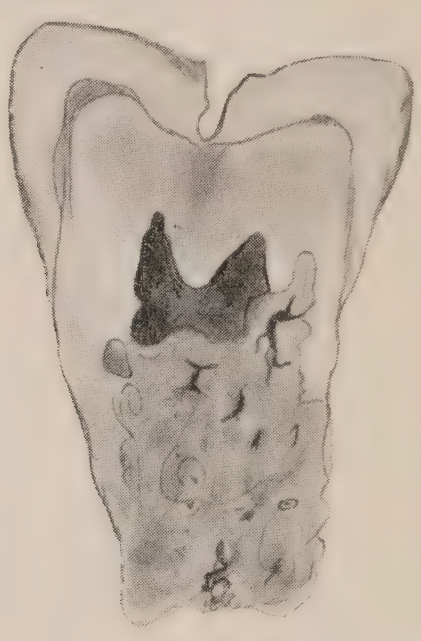

Fig. 3. Fig. 4.

Fig. 3.—Longitudinal section through the middle of the tooth, showing the general relation of the new tissue to the pulp cavity.

Fig. 4.—Similar section, showing the extension of the new tissue upwards into the dentine by the sides of the pulp cavity.

neck the dentine is represented only by a thin layer on the outside, which yet further thins out as it goes downwards, so that on the one side it only reaches a short distance below the pulp cavity, whilst on the other it reaches two-thirds of the length of the root (fig. 3). Its outer surface is smooth and unaltered, but the

inner surface of this skin of dentine is very irregular.

The whole interior of the root portion is solid, no trace of pulp cavity extending down the roots in the form of root canals being visible.

To the naked eye the tissue which thus replaces the dentine of the roots resembles a coarse secondary dentine; slight appearances of rounded globular forms are to be detected, and there are dark spots, which are really spaces, in it.

Upon closer examination it is seen with the naked eye, and still better in microscopic sections, that this coarse tissue extends upward as far as the floor of the pulp cavity, which is partly formed by it; and at both sides of the pulp cavity, but more particularly on one side, it reaches upwards nearly as high as the cornu of the latter. Here, however, it diverges outwards so as to leave a material thickness of dentine between itself and the pulp cavity (fig. 4).

On microscopic examination it is found to be a coarse calcified tissue with a concentric arrangement round numerous small areas and with a good many large spaces which are of lacunal character; the cementum, which is present upon the outside of the dentine where this forms part of the exterior of the roots, is entirely absent over the portion composed of

this coarse tissue, the outer surface of which is similar in structure to its interior (fig. 5).

Towards this tissue the dentine in the interior of the tooth everywhere presents those festooned outlines which are characteristic of absorption.

It remains to interpret the appearances thus

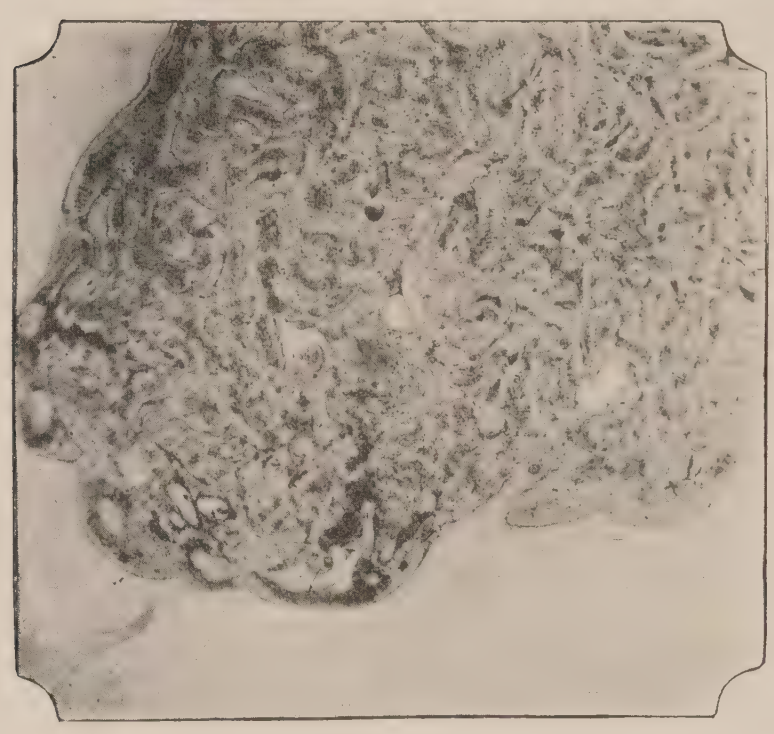

FIG. 5.—A microphotograph of the apex of the root showing the structure of the new tissue, and the absence of the cementum over it.

far described, and two hypotheses present themselves: the one that this was the original structural formation of the tooth, the other that the tooth was originally normally formed, and that the substitution for the normal tis-

sues of this coarse calcification was a subsequent process, the result of disease. A careful study of the conditions found, renders it almost certain that the latter is the true hypothesis.

The relations of the new tissue to the pulp cavity, around which a little dentine is almost everywhere left, just as often happens in the absorption of a temporary tooth; its relation to the dentinal tubes which are everywhere abruptly cut short where it touches them, and lastly the festooning of the dentine along the line of junction, all clearly point to dentine of normal character having once been present, but having been removed by a sweeping process of absorption which, so far as one can guess, has extended upwards from the apex of the root as high as the pulp cavity; in this the pulp must for a long time have remained alive, as is evidenced by the resistance which its immediate walls have offered to the advance of the destructive process. At one period, then, there must have been a mass of soft tissue which has been modelled, by the persistence of the tooth socket below and towards the upper part by a shell of dentine still remaining, into exactly the old form of the roots of the tooth. This has swept away even the cementum, and then has itself undergone a course of rapid calcification, reproducing in a new tissue the old form. There are, of

course, countless examples of absorption succeeded by a partial calcification of the absorbing tissue, but I am not acquainted with any instance of its being so extensive nor of its reproducing in such exactitude the outward form of the structures which it has removed.

It would, of course, have been quite impossible to have diagnosed this condition prior to the extraction of the tooth, and the failure of treatment seems to have been inevitable; it will be very interesting to observe whether the same sort of thing happens with any of the other teeth which are now showing indications of tenderness in their sockets.

Curiously enough, whilst this tooth was in my hands, another was sent to me by Mr. Vincent Cotterell, which might almost be described as an earlier stage of the same disease. This is a mandibular third molar over which the gum had not at all receded and was not inflamed. The two contiguous molars had been removed and the bicuspid had a large filling in it which was removed, as no other cause could be discovered for the pain complained of. The pain continuing, after several examinations a small cavity was discovered under the gum in the wisdom tooth, which at the patient's request was extracted.

The cavity, which was situated some distance below the termination of the enamel, had a small

orifice and expanded considerably inside; it was little discoloured and was quite hard, and it had not the ordinary appearances of caries.

On cutting sections it was found to run a good way upwards above its orifice and to approach very nearly to the pulp cavity, though just as

Fig. 6.—Mr. Vincent Cotterell's case. A transverse section, cut a little way below the neck of the tooth. The oval pulp cavity, is everywhere seen surrounded by dentine, which remains only as a thin layer. The irregular space which extends diagonally across to the left-hand lower corner of the section is the absorption cavity, and the sharp tongue which extends upwards across its middle is a piece of bone-like new tissue, which is shown more highly magnified in the next figure.

in the first specimen, a thin layer of dentine everywhere, so far as could be ascertained, separated it from the pulp (fig. 6).

None of the appearances of caries were discovered by microscopic examination, but the walls of the cavity were festooned by the lacunæ of Howship, and in many places there was distinct calcification of the absorbent tissue, although at no place had any considerable proportion of the excavation been filled up; in this, just as in the other, it is obvious from the re-

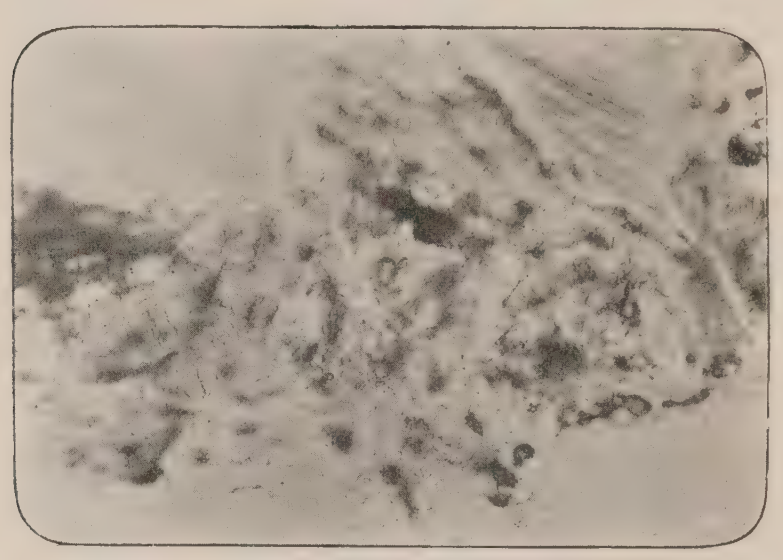

Fig. 7.—The bony tissue which runs from the surface of the excavated dentine.

sistance to absorption afforded by the walls of the pulp cavity, which resulted in the leaving of a thin skin of dentine round it of somewhat uniform thickness, that the pulp was alive while the absorption was going on.

It differs, however, from the first specimen in that the calcification is of a much more regular

character; well formed lacunæ and canaliculi abound in the new tissue, and where it is of some thickness it is laminated, the lacunæ flattened parallel with the laminæ, and their canaliculi disposed exactly as in true bone (fig. 7). It therefore presents resemblances to the specimen described before this Society by Messrs. Ackery and Colyer, but with the difference that in this case the bone is formed not inside the pulp cavity, but in an excavation formed outside it.

Little or nothing is known of the conditions antecedent to this sort of action; in both cases the teeth had apparently healthy pulps, and if we say that it was a result of an inflammatory process we are little nearer to an explanation, for what is to set up this inflammatory process in such a position?

From the situation of the excavations, in neither case could pressure of a contiguous tooth have had anything to do with it, and in each case it is obvious, and particularly in the last, that after effecting an entrance into the tooth substance the invading growth largely increased, so that the orifice was small in relation to its extent inside.

It is noteworthy that in neither case has the pulp, although very nearly approached, made much attempt to protect itself by the formation of secondary dentine; indeed in one specimen

there is no trace of such action, and in the other but a doubtful indication; it may therefore be assumed that the approach of absorption sets up far less irritation than the approach of caries.

## Discussion.

The President said that absorption cavities just under the line of the gum were not infrequent, and he had himself met with them perhaps a dozen times, generally on the lingual surface of the mandibular incisors or on the proximal surface of mandibular canines.

Mr. Dolamore asked whether there was any record of soft tissue in the cavity in the second case, or remains of soft tissue.

Mr. Northcroft asked if Mr. Tomes thought the pains were due to periostitis or inflammation of the pulp, because if the pains arose from an inflammation of the pulp they would have been cured by destroying the nerve and the pulp, or both, but if it were of periostitis it would be probably necessary to remove the tooth in order to cure the pain.

Mr. Schelling asked whether the entire amount of absorption took place before the calcification began in the first instance, or whether it was calcifying in one part of the cavity and absorbing in another.

Mr. H. Lloyd Williams understood from what Mr. Tomes had described that the absorption had taken place in the ordinary manner by large giant cells, and that the deposition had probably taken place as deposition did in ordinary exostosis. When there was such a large cavity as was shown, it occurred to him, especially with regard to the second case, where the nourishment of the cells depositing the new bone was derived from? The cases were also very interesting as perhaps clearing up certain points in a recent paper by Mr. Storer Bennett. He (Mr. Lloyd Williams) was not convinced by the theory of ankylosis that Mr. Storer Bennett gave in November, and the

possibility of cells which at one time deposited cementum absorbing that cementum and dentine and then redepositing bone seemed to be established by Mr. Tomes' paper. The two papers appeared to bear upon one another, and probably there was a good deal more to be said upon the question of ankylosis.

Mr. Reinhardt said Mr. Tomes compared the absorption with the absorption of the roots of the temporary teeth, and spoke of a slight layer of the dentine being left round the pulp. He should like to know what Mr. Tomes thought was the process that took place.

Mr. Ackery, referring to the case mentioned by Mr. Tomes, and described by Mr. Colyer to the Odontological Society in January, 1893, said: It may be interesting to put on record a few facts as to the condition of the tooth and the circumstances leading to its removal. The tooth in question was removed from a medical man, aged 33; it was a left maxillary second bicuspid, and had erupted with its crown through the buccal alveolus and its cusps in contact with the buccal mucous membrane. Having commencing caries in the crown fissure and being altogether useless for mastication, it was extracted. On removal the root appeared about one-third less than the normal length, was very smooth and round at the apex, and had a very minute foramen. It showed no irregularity of surface, such as is usually seen in cases where absorption and re-deposition have taken place. Mr. Colyer made several sections which showed even more perfect bone than that in Mr. Tomes' very interesting specimen. In one section a single Haversian system appeared completely surrounded by true dentine. It was a matter for regret that no section had been made throughout the length of the tooth, and consequently no record remained as to the relation of the new formation to the dental pulp, or of the resistance of the hard tissue around the pulp to absorption. In contradistinction to the case mentioned by Mr. Tomes there was absolutely no history of pain.

Mr. Tomes, in reply, admitted that possibly such cavities were not so very uncommon in a small degree, and that

they would pass, unless looked at with particular care, as incipient caries. Really absolutely nothing was known as to the pathology and as to what set the process going. Mr. Dolamore asked if he (Mr. Tomes) had found any remains of soft tissue in the cavity. He did find some shrunken red stuff in one or two places in the excavation in the second tooth. In reply to Mr. Northcroft, he did not see either of the teeth until after they had been extracted. In one instance he saw the patient, who had other teeth which were threatened in the same way. In the other he only saw the tooth after it was extracted. In the second case it was distinctly noted that there was absolutely no redness or inflammation about the tooth, that it was not tender to pressure, and in fact that its appearances were absolutely normal. He took it therefore that it was probable in that instance that the pain was in the pulp. The patient was under observation some time before the tooth was extracted, because the lesion was not detected at first. Had there been an amount of inflammation that would have set up the pain it would probably have been noticed. In the first specimen, where almost the whole root portion of the tooth had been swept away and reformed, there was great tenderness in the socket, but the tooth was implanted in this socket not by its normal tissues but by new ones, its cementum being all gone, and it was difficult to say whether the pain was in the socket or in the pulp. Of one thing he was quite certain, that both the pulps remained alive to a late date, because of the inability of the absorbent tissue to make a hole into the pulp cavity. Replying to Mr. Schelling, in the second case there was a little absorption going on in some places still, and in other places a little deposit was going on, and in other places a good deal of deposition. In that case the two processes were going on at the same time in different portions of the area, but in the first case the absorption must have gone on almost completely before any redeposition took place, because the action took place in so long and deep a tunnel that the first points of calcification must almost necessarily have been the most remote points,

otherwise it was hardly possible that the lime salts could be carried up. What probably happened in the first instance was that the whole of the absorption took place and then a comparatively rapid and rude sort of calcification took place. He should guess the calcification in the second tooth would have been a slow and orderly process; the other he imagined was done all in a hurry and almost all at once. Mr. H. Lloyd Williams had asked how the giant cells got nourished. He supposed that blood vessels must have formed in the absorbent organ while it was growing into the tooth so as to nourish it. With regard to the question of ankylosis, it might throw some light on that question, but there was the rather remarkable circumstances that in the first tooth he described, where the whole of the root was reformed, there was no ankylosis though the cementum was gone, but the socket of the tooth still served to mould it to make a new growth in the shape of the old tooth. In reply to Mr. Reinhardt, he thought that almost all soft tissue was capable of sorts of calcification. Calcification was found occurring in all parts of the body, and it was known that the giant cells were very prone indeed to recalcification. The surface at all events of the absorbent organs must have been entirely composed of the giant cells. He was very much interested to hear Mr. Ackery's account of the specimen he and Mr. Colyer described some time ago—particularly because there was no pain. In both of his cases there was pain, but there was nothing to be seen on the second tooth to show why there should have been pain, except that the pulp cavity had been approached, but not reached, by the absorption. Unfortunately it was not known in Mr. Ackery's case how near to the pulp cavity the absorption had reached.

The PRESIDENT, having thanked the various speakers for taking part in the discussion, and Mr. Tomes for his valuable paper, adjourned the Society till May 1.

# Odontological Society of Great Britain.

## ORDINARY MONTHLY MEETING,

*May* 1, 1899.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

The SECRETARY read the Minutes of the last meeting, which were confirmed.

The following gentlemen were balloted for and duly elected members of the Society:—As a resident member: WILLIAM JAMES MACDONALD, L.D.S.Eng., 32, Weymouth Street, W. As non-resident members: GEORGE OWEN BETTS, L.D.S.Eng., Cambridge; DOUGLAS E. CAUSH, L.D.S.I., 63, Grand Parade, Brighton.

The CURATOR (Mr. Storer Bennett) presented several specimens to the Museum. He was afraid he rather gave himself away some months ago when he presented, on behalf of Mr. West, some mineral teeth of an early form with tubes in them for retaining the bolts of swivels. He had never seen anything like them before, but Mr. Coxon and several other members had since sent him for the Museum, specimens more or less of a similar character. He exhibited a molar and a bicuspid sent by Mr. Anderson; both teeth had tubes for the bolts of the swivels. There was no metal round the tubes in the mineral substance, but in one specimen, presented by Mr. Murphy, and which was evidently of a later date, the tube had been

made with platinum. Mr. Reinhardt had been good enough to send a lot of specimens of very early forms of mineral teeth, and amongst them a piece of mineral and gum block work with a tube of a similar character.

Mr. Morton Smale, to whom the thanks of the Society were greatly due for so many valuable donations to the Museum, had sent, amongst other things, the skull of a common porcupine (*Hystrix cristata*), with considerable absorption of the alveolus and more or less absorption of the teeth, the absorbed alveolus showing very remarkably the thinning and cupping of the bone commonly found in the specimens of pyorrhœa alveolaris in the Museum. He had placed on the table two or three specimens from this collection of pyorrhœa alveolaris, some showing the cupping with dilation of the alveolus round the sockets of the teeth, and a comparison of those with the specimen presented by Mr. Morton Smale was very instructive.

Mr. Bennett also exhibited a piece of amateur dentistry, an amalgam concocted from the scrapings of a bullet twenty-five years ago and inserted by an amateur into a mandibular bicuspid. The filling had remained quite comfortable until six months before it was taken out, when the patient suffered from periostitis. The specimen was sent by Mr. Frank Morley. It was historically interesting, but did not help very much as a guide for composing amalgams which were likely to last twenty-five years in the future.

The last specimen contained a very remarkable odontome which Mr. Morton Smale had presented to the Society—the skull of a Cape buffalo (*Bubalus caffer*). There was a large cystic cavity on the right side. The second permanent molar had never erupted, and the third one was lying horizontally with the crown pointed directly backwards towards the pterygoid fossa, which was very much distended. The whole of the palate in the living state was occupied by an agglomerated mass of a composite odontome. It was very difficult to say what was the history of the case, as it was from a wild animal which had never been in captivity. Mr. Smale considered that the odontome might have been formed from the germs of the first denti-

tion, and be the result of a fall or injury to the mother or calf, causing several of the germs to coalesce, which, when calcified, produced the odontome. The same cause might also displace the germs of the third molar. At the same time Mr. Storer Bennett could not help thinking that no matter what caused the breaking up of the tooth germ to form such an extraordinary odontome, it could not have acted on the third molar and displaced it, because there was no appearance whatever of destruction or alteration of its shape. Mr. Morton Smale considered that the germ of the third molar had distended the periosteum and caused the new formation of bone.

## *On Limitation of the Gape and its Surgical Treatment.*

By C. B. Keetley, F.R.C.S.

Both dental and general surgeons occasionally meet with cases in which the gape, or power of separating the jaws, has been limited as a consequence of operation on or injuries of the jaws or the cheeks, and in which the temporo-maxillary articulation itself is normal. In the early part of this century such cases appear to have been more common than now in consequence of the lengths to which mercurial salivation used to be pushed, and the resulting sloughing and necrosis. Other causes which have happily though more recently diminished are noma and slow poisoning by phosphorus.

We still, however, from time to time see cases occurring as a sequence of burns, scalds, and operations for malignant disease; and, unless the Czar's peace conference is very successful, many will result from the action of expanding bullets and the terrible fire of modern artillery.

The possibility of infecting the mouth with

spreading gangrene or the jaws with necrosis by operative dentistry conducted without disinfection of instruments is to be borne in mind. I have twice in the past year seen cases in which there was strong suspicion that this had occurred. One of these two cases would certainly have resulted in contraction of the gape had not the infection been fatal; gangrene, commencing at or near one tooth socket spread along the gum, destroyed the alveoli of the corresponding side, the floor of the tongue on the same side, the pillars of the fauces, and the tonsil.

When, with a normal temporo-maxillary joint, the gape is narrowed, the restriction is due to either:—

(*a*) *Contraction* of
- (1) Skin, or
- (2) Mucous membrane, or
- (3) Intermediate structures;

or to

(*b*) *Adhesion*, due to removal of
- (1) Mucous membrane, or
- (2) Bone.

The following cases are examples of procedures for the prevention of contraction due to removal or destruction of skin. In this class of cases the difficulty of closing the eyes and mouth forms a symptom so obvious and so repulsive that it attracts more attention than the difficulty of

opening the jaws. But the two apparently, though not really, opposed conditions may co-exist.

*Case* 1.—Thirteen or fourteen years ago (*vide Lancet*) an infant was brought to me with nearly the whole of its right cheek covered by a hairy mole. Measurement showed that the mole was as broad as half the circumference of the upper arm, and as long as the distance from the shoulder to the elbow. I shrank from so denuding the upper arm to furnish skin for the cheek; but suddenly it occurred to me that the hairy mole would do very well for a covering for the upper arm. Accordingly I exchanged the places of the fine white skin of the arm and the shaggy mole of the cheek. Both as regards movements and appearance the result was very good, and remained so when I last saw the child four or five years ago. The child's good looks seemed to me scarcely more lessened by the mark of junction of the flap than by a dimple.

*Case* 2.—A poor girl, an imbecile epileptic, was burnt in the usual way. *i.e.*, during a fit, so that the skin, every layer of it, was almost entirely destroyed from just above the left eyebrow and below the right down to the middle of the neck. The left eyelids, the nose, cheeks, lips, chin and jaws were skinless.

The left eyelids were now united by suture,

and the whole surface covered with large grafts, like Thiersch's in size, but of unusual thickness, some being practically the whole thickness of the skin. One side of the face and nose was operated on at a time, for convenience of dressing, resting and feeding. Lastly, the sutured left eyelids, which had united, were cut apart. The immediate result was good. The patient was removed to an asylum.

But to obtain the best possible results as regards both mobility and appearance in such a case, pedicled flaps should have been used. Under all the circumstances of this particular case, the patient being imbecile, I think the procedure followed was the right one.

Contraction of the gape thus presents no difficulty, and is of small interest when the cause lies in the skin. And the same may be said of subcutaneous fat and fascia. In fact, in both the above cases the tissues which are immediately subcutaneous were involved. When there is a contracted subcutaneous cicatrix it should not only be cut through, but should also be completely excised before the graft or transplant is put on. The removal of such a cicatrix is facilitated by cutting through it until the soft parts are reached beneath it; then the two segments can be raised and cut away separately. I have operated in this way many times in the

face, hands, and other parts, and have sometimes found a second division of the scar tissue transverse to the first helpful in getting it away.

We now come to a class of cases of the highest interest, viz., those in which the *mucous membrane* is the principal concern.

Dr. Korteweg, the Professor of Surgery in the University of Amsterdam, published in 1891 a masterly paper which, for historical and surgical knowledge of and clear insight into the subject is complete, and establishes a base from which further advances in this department of surgery will proceed.[1] Professor Korteweg writes of Mr. Christopher Heath that "in a lecture ('Closure of the Jaws,' *Brit. Med. Journ.*, 1887), delivered before the members of the Royal College of Surgeons of England, he said that under the influence of those silver plates [viz., plates modelled exactly upon the grinding sides of the upper and lower jaw, and provided laterally with ascending and descending wings, covering the alveoli of the jaw, and preventing in this way the union of the opposite surfaces], the surface of the wound is covered with a fresh mucous membrane even at those places where not a trace of mucous membrane remains in the vicinity. According

[1] "Meloplasty," *Annals of Surgery*, vol. xiv., p. 21.

to the results attained, he completely rejects Esmarch's opinion that the mucous membrane does not regenerate, but is always drawn over the wound." Korteweg adds, "As far as I know, Heath is unique in this assertion," and the Amsterdam professor evidently regards Esmarch's view as an established fact, and Heath's as not requiring further notice. The case of Mr. B. which I show to-night satisfies me that the question raised is not to be so settled, and makes clear how Mr. Heath formed his expressed opinion. The gentleman in question suffered from an epithelioma of the left cheek (oral surface). With the greatest care I cut away the mucous membrane of the left cheek, almost from the commissure of the lips back to the last molar tooth, and above and below to within a quarter of an inch of where it was reflected from the alveoli. I fully expected to have to perform a secondary plastic operation, and to my surprise, the case healed with the cheek well lined with apparently normal mucous membrane, and with very slight limitation of the gape. It should be added that the muscular layer of the cheek on the base of the ulcer was excised in an oblong piece of the area of at least a half-crown piece. At the time of operation traction with catch forceps did not pull the cut mucous edge more than a quarter of an inch from

the alveoli. I do not believe that the two cut edges were ultimately pulled together right across the inside of the cheek. Nor do I believe that new mucous membrane was formed *in the gap*. Such a new formation would have been observed at the time.

What I believe really took place was that under the extending influence of the cicatricial contraction, which ultimately brought near together the cut edges of the mucous, *the narrow strip of that membrane left at the operation widened by interstitial growth*, just as the whole sac of skin which contains the body of an infant enlarges till it has room for, successively, the child, the adolescent, and the man, or just as the skin of a limb enlarges over the growth of some giant tumour. This does not seem to me to be correctly described as a mere "drawing of the skin over the wound." It is that, of course, but a good deal more.

No silver plates or other prosthetic appliances were used in my case. I do not believe the good influence of such things endures. When cicatrices are cutaneous as well as subcutaneous mere mechanical treatment is followed by relapse, which advances *pari passu* with the healing of the surface, and this holds true of mucous cicatrices except when mechanical force is kept up or constantly re-applied.

Mr. B. was operated on four years ago and there has been no recurrence.

The next point to which I would direct attention is the undeservedly high position which is held, even to this day, by the Esmarch-Rizzoli operation of wedge-osteotomy of the jaw in front of the cicatrix. Korteweg noted this point in the paper already quoted. His explanation is that all plastic operations on the soft parts were discredited by their frequent failures in pre-antiseptic times.

One of the largest and best modern English works on operative surgery describes no other operation for jaw contraction, cicatricial or otherwise, than Esmarch's. In truth this operation ought seldom, if ever, to be used at all, so long as the temporo-maxillary articulation is not ankylosed; and even then an excision of the joint itself might be preferable.

Or a procedure might be applied to this joint which I tried a year ago in the elbow.

*Case* 4.—A patient of Dr. Curtis's of Orpington, a young woman, had tuberculous disease of the elbow joint. The cartilage was destroyed. I removed it and a thin layer of bone from the humerus and ulna, and took away the head and neck of the radius, as the disease extended to the neck of that bone. Having rounded and smoothed the surfaces carefully, I placed between them a

soft sheet of gold, not nearly thick enough to be called a plate, but many times thicker than ordinary gold leaf. Here is a specimen of it. I then closed the wound and fixed the joint for a month. Then I reopened the wound, removed the gold, and commenced passive movements, which were smooth and painless and of considerable range. Six months afterwards the good result was maintained. The principle of this operation is, of course, simply to keep the opposite surfaces of the joint and its pouches from uniting until they have had time to smooth off and cicatrise. The gold should be pressed well into both anterior and posterior synovial pouches, of course removing all diseased synovial membrane first.

Many plastic operations have been performed for cicatricial contraction of the jaws. With antiseptic precautions and correctly managed iodoform gauze dressings such operations ought to do well.

As examples may be given (1) Mott's operation (1834). If I understand this rightly, it was done as follows. The cheek was slit from the commissure of the lips back to the anterior border of the masseter. When each border had cicatrised to its corresponding line of alveoli, an incision was made at some distance from the edge of each gum, and the cheek freed and re-united.

(2) Blasius (1866) also proposed to split the cheek and unite it to the gums. But he suggested afterwards cutting the cheek far enough from the teeth to obtain flaps which, when turned over and sutured together, would form a lining for the cheek. The gap in the outside of the cheek was to be closed by *décollement*, *i.e.*, by loosening the cheek well from its deep connections and slipping it over the gap, making long incisions of relaxation if necessary.

(3) Gussenbauer (1877) cut a flap from the skin of the cheek with its pedicle posteriorly. He turned this through the divided cheek and lapped it round the inner surface of that muscle. When it had united he freed its pedicle and carried that forward to the angle of the mouth. The place of the skin removed from the cheek was supplied by a flap from the neck.

(4) Rotter (1889) passed a flap from the arm through a fissure in front of the masseter muscle into the mouth with which to take the place of cicatricial tissue divided or removed.

(5) Korteweg (1891) cut a flap from the upper lip, carefully preserving the coronary artery in the pedicle; he then turned this back until it closed the gap in the cheek.

I would only remark on these operations that any plan which involves turning the skin of the cheek into the inside of the mouth is objection-

able in the male on account of the hair, and in the female on account of the scar. Generally, I think it would be preferable to obtain the skin from the arm.

If the mucous membrane of the lips and opposite cheek were intact, the defect in the injured side could be sufficiently supplied by pedicled flaps from the inside of the lips. The defect in the lips thus caused could be filled immediately by similar flaps from the inside of the sound cheek. That a sound cheek could easily spare a good deal of its mucous membrane is demonstrated by the case of Mr. B. shown here to-night.

There remains for consideration contracture after facial paralysis and limitation of the gape due to adhesion and contraction after removal of bone, especially after removal of the superior maxilla. I think the length to which this paper has already attained necessitates the postponement of that subject to a future occasion. I am sorry because, as your secretary Mr. Lloyd-Williams and myself have found, it is a serious one with reference to the fitting of dental, or rather buccal, appliances.

## Discussion.

Mr. William Hern said it would be within the remembrance of the Society that a few years ago he showed a case of limitation of the gape with almost fixation of the two jaws, which was going to be operated upon by Mr. Bland Sutton. He thought it might be interesting for the Society to see the boy since Mr. Bland Sutton operated about three years ago. He exhibited a model taken of the mouth before the operation. The boy wore for a considerable time a powerful spring in the form of a letter-clip turned the wrong way, and acting to open the jaws during the day, but it fell out at night, and even with that extreme amount of force the only opening to be obtained was that represented by the model. Seeing that it was perfectly hopeless to get any result by mechanical means, he asked Mr. Bland Sutton to see the case, and he recommended removal of the condyles. The right condyle was first removed, and it was then found unnecessary to remove the left, because the trouble was completely relieved and the boy was able to open his mouth very widely. No recurrence had taken place. The boy had made remarkable strides in growth since.

The President said that dental surgeons did not have so much to do with the subject as surgeons might imagine. He did not think he had met with a single case that had not recovered of itself. He remembered one case of limitation of movement lasting for three months from a too forcible extraction of a mandibular third molar. He voided some pus first of all by an excavator, and treated the wound with antiseptics; the patient, however, got impatient at the end of six weeks or two months, and went to see Sir James Paget. There was a certain amount of necrosis, and he was advised to continue with the treatment. After three months a piece of bone about the size of the top of one's little finger came away, and recovery ensued. He thought

Mr. Keetley's explanation of how mucous membrane might cover the surface after a large portion of it had been removed was exceedingly interesting.

Mr. Keetley, in reply, said he had seen Mr. Hern's case, which was an extremely good one. He had not attempted to deal with that class of case in the paper except incidentally. If he had such a case as that of Mr. Hern's to deal with, he should try very hard to avoid excising any bone, or more than a mere layer of bone, because, as was well known, it was a serious thing to alter the relation of the maxillary to the mandibular teeth. There was always a risk of that if any considerable amount of bone were removed from one side of the jaw, and even if from both sides. He should try to get a joint after osteotomy by smoothing the surfaces and rounding the corners off very carefully, and then placing for a time a thin gold plate or a very thick piece of gold tissue between the bone surfaces and the soft tissues at the side. What originally led him to do that was really the suggestion of a dental friend that a gold joint could be made in some cases of ankylosis. The worst of gold joints was that all foreign bodies tended to work out even if they were quite peacefully left at rest, but anything in a joint would be more likely to work out. He had for some years been in the habit of putting in little aluminium plates to form button sutures for the radical cure of hernia, and in the vast majority of cases no irritation was caused by them. But one or two of them, for some reason or another—perhaps they lay too near the surface of the skin—began to cause irritation, which he thought was possibly due to the pressure of the clothes or something outside the skin, which made the patient uncomfortable. He cut them out, and always found that each of the buttons lay in a beautiful little bed, absolutely smooth, with a surface so glossy that one could almost see oneself in it as in a mirror. He thought that was the kind of surface to obtain at the end of a bone in making an artificial joint, and that led him to try the temporary gold plate, and it had turned out quite a success. In cases of jaw ankylosis, as a rule, there were no micro-organisms to fear.

## *Deformities of the Teeth and Palate due to Nasal Obstruction.*

By Mayo Collier, F.R.C.S.Eng., M.S.Lond.

Mr. President and Gentlemen,—My first duty to-night is to thank you for permitting me to come here and say a few words on a subject which you, as dentists, and I as general surgeon, are both interested. That subject is the peculiar deformity—specimens of which I am placing now before you — of the maxillary teeth and palate due to some cause or other. You will notice that here I have a case where the whole range of the maxillary teeth are well inside the range of the mandibular teeth, and in this case the palate is very elevated; in fact, there is extreme atrophy of the whole maxilla compared with the mandible. In this case you will notice there is general atrophy, with extreme elevation of the palate and destruction of all the teeth, and there is perforation also of the palate in front. In this case, as one often sees, the arch of the maxilla is simply disarranged to the arch of the mandible. Instead of the arch taking a certain

curvature it is apparently squeezed, so that the incisor teeth of the maxilla are well in front of the incisor teeth of the mandible. *Per contra*, we find sometimes cases where the incisor teeth of the maxilla are well behind the incisor teeth of the mandible, and with apparently no disarrangement of the molar teeth of the maxilla.

Various explanations have been offered for this state of things, and on many occasions when I have attempted to give my personal views on the subject I have been met, after three-quarters of an hour of close argument, with the observation, "Well, we know well enough that these cases are hereditary." Now, of course, that is an explanation very familiar to you all, but I would say that your explanation of heredity tells us little or nothing. You substitute a word or a name for an explanation. The worst of this is that if you accept the word or name for an explanation you will never arrive at any result whereby benefit or prevention can be attained; whereas if what I am going to say to you to-night is correct, if my explanation of this deformity is correct, we have a means of preventing this disease and, of course, in preventing it we shall prevent a very large amount not only of disfigurement of the maxilla, but of the whole face. I need not ask you to call to mind the facial expression associated with this peculiar

distortion of the maxilla—the under-hung jaw, the flattened face, the protruded nose, and the general appearance of more or less want of mental faculty.

Now I have heard three explanations given for this state of things. One was the hereditary tendency. The term "hereditary tendency" would cover an immense field, but I suppose that what is meant is that the individual inherits from his parents the tendency to this peculiar deformity, commencing at his birth, and progressing until full development of the maxilla. Then I have heard that there is a tendency, although the maxilla may be fully and properly developed at birth, to this disposition of the high palate and irregular teeth—we will call it a post-natal tendency to the development of this state of things, although the child may have a perfectly symmetrical jaw at birth. I am told that there is a tendency for the jaw to become distorted and the maxilla to become smaller than the other. Then the third explanation is that when an individual gets obstruction of the nose from a common cold or otherwise, the effect of this is that sleeping with the mouth open, the constant contraction of the muscles on the maxilla causes a compression of the upper alveolar arch, and so disarranges the relation between the palate and the alveolus. The palate is not elevated, but the

alveoli are brought down, and the squeezing of the muscles is sufficient to distort the maxilla. I may remind you that this is almost impossible, because there is no muscle attached to the maxilla capable of exerting sufficient traction or pressure. The buccinator is the only muscle attached to the margin of the alveoli, and the line of its traction is directly backwards. I may remind you that the masseter muscle is altogether posterior to and hardly in contact with the upper jaw. Its attachment is to the malar bone and zygoma, and not, except by a very few fibres, to any portion of the upper maxillary bones.

Now I have laid before you the ordinary and current explanations for these serious distortions and deformities, and I submit to you that such explanations are no explanation at all; they are insufficient and irrational and explain nothing.

I beg to submit to you a cause or explanation of these deformities that is at once simple, efficient, and constantly present and capable of producing the deformities that we are discussing this evening. Now I would remind you that associated with this state of things the septum of the nose is nearly always, from the pressure and elevation of the palate upwards, more or less crumpled or deflected. Deflections of the nasal septum, causing obstruction, are one of the commonest affections of the nose.

The first impetus given to me to examine into this question was an observation made by the late Sir Morell Mackenzie that he was not satisfied with the usual explanations offered to account for the common deviations of the nasal septum. He said, "I am not satisfied with the usual explanations given of this deflection; can you take in hand and investigate the matter and see what you can do?" This was the first impetus given to me to examine into this question. I did examine into this matter very carefully. In the first place I instituted an examination on my own account of living subjects. I examined 1,050 cases without cessation. I made a careful note of the exact condition of the cases, and this was the result. Of the 1,050 cases I found 90 per cent. had some bony deflection of the nasal septum. Of course, an obstruction of the nose may be due to some elevation or prominence or growth of the outer wall or roof of the nose, but I say 90 per cent. of these cases had some obstruction due to deflection of the septum. Of those 90 per cent., not 1 in 50 cases was affected below the age of ten. All young persons had perfectly straight septa. Therefore you must admit at once that that goes a long way towards counteracting the view that deflections of the septum are at all events hereditary, and that some cause is present after

birth to dislocate what was previously a straight septum.

Now, Sir Morell Mackenzie examined 2,850 dried skulls in the College of Surgeons to see if there was any permanent record of this deflection of the nasal septum in them. He found 1,850 were affected by a permanent distortion of the bony septum of the nose. That would leave out a large number where the cartilaginous septum of the nose could not be examined. We have arrived at this point upon our investigations about the septum of the nose that, whatever the distortion, it is the result of some cause after birth. I think, sir, I am entitled to say that. In a very small proportion—not 1 in 100—was there any deflection or distortion of the septum of the nose at the age of 1, 2 or 3. We found very few cases, not 1 in 50, up to the age of 10. The earliest time was from 8 to 10 years of age. Now that would negative any suggestion of heredity. In addition to that, if I can show you that I can bring about this deflection of the nasal septum and manufacture a force whereby the walls of your nasal box will collapse, I think that will be corroborative evidence that a state of things may exist capable of producing these deformities. It is well known that the nasal septum is a thin, partly bony and partly cartilaginous partition in the mid-nasal region,

and that the main office of this structure is to expand the mucous area of the nose. It has little function in maintaining the nose in its position, nor any function in acting as a buttress to the bones of the face. I would remind you that you could have complete absence of the septum of the nose without disfigurement. A child can be born not only with a defective palate, but can lose the septum in after life through syphilis or otherwise without the smallest distortion or want of symmetry of the nasal organ.

I would ask you to bear with me for one moment and to consider what would happen provided one side of the nose gets blocked up. Naturally a greater stream of air will pass on one side than on the other. The force of nasal inspiration amounts to a certain number of ounces on the square inch, and if this strikes on a thin and easily displaced septum, and it will be understood that with no counteracting force to oppose, this pressure will tend to displace the septum to the other side. Once having done so you will see how the displacement tends to increase. If you will follow me for a moment I will endeavour to point out to you what must be the inevitable result. If one side of the nose be obstructed—and very little is required to obstruct it—the inequality of nasal respiration must

throw a very large pressure on the whole of the area of the septum, and so displace it further and throw a pressure on all the walls of that nasal box which is closed up. A stream of air passing down one side and no stream of air passing down the other side, the result is that the stream of air passing over the palate into the larynx will draw out a certain amount of air in the closed side of the nasal chamber. One may doubt this; but if you will take an ordinary piece of bent glass with mercury in the bend and attach a rigid tube to it and put it into the nose, you will notice at each marked inspiration that the mercury will rise distinctly on the proximal end and fall into the distal one. That is a measure of the amount of rarefication of the air that must take place in that chamber during each inspiration. That is a record of a fact which there is no other explanation for. It is an experiment you can make yourselves on all occasions. If you convert that into inches of mercury you will find that it comes to 2½lbs. to 3lbs. of pressure on the square inch. Taking the septum of the nose as nine square inches you have there a force of 3½lbs. acting on a thin septum 20,000 times a day, and you will not be surprised to find that this septum is pushed over if one nostril is permanently blocked for a considerable time. Not only is the septum pushed over, but you have a proportional force

acting on the palate, on the upper jaw and on every wall of the nasal box—a force acting 20,000 times a day; and it only requires you to draw on your imagination to the smallest extent to satisfy yourselves that that force acting for twelve months or three or four years is quite capable of causing the atrophy and distortion associated with these cases.

If that argument is not sufficient I would draw your attention to experiments which have been reproduced fifty times over by Professor Ziem. He has taken young animals—sheep, calves, goats—to see what the effect would be of blocking the nostril permanently with antiseptic wool on one side. I say it is of supreme interest to you, because if you are capable of preventing these cases by judiciously ventilating the nose in youth, or pointing out to the parents that by doing so you can prevent the frightful distortion of the palate and upper jaw which you see in these cases, you are doing a great service to mankind. Now Ziem has proved that every obstruction of the nose when acting for some considerable time exerts widely-spread consequences on the development of the skull in young animals, one of whose nostrils is completely closed up for some long time. Not only the upper jaw, but the whole of the frontal bone was affected. There was seen a deviation of the intermaxillary bone and the

sagittal suture towards the shut up side, also a lesser length of the nasal bone, of the frontal bone, and of the horizontal plate of the palate bone. The palate bone, as compared with the other side, was distinctly atrophied. The nasal bone was atrophied and the frontal bone was atrophied, and the suture was pushed over. There was less steep elevation of the alveolar processes. There was a smaller distance between the anterior surface of the bony auditory capsule and the alveolar process, also between the zygomatic arch and the super-orbital border, and smaller size and a symmetrical position of the vascular and nerve canals on the closed side of the nose. The distance of the two orbits from the middle line was unequal, which, as has been observed in men, leads to asthenopia, astigmatism and strabismus. The orbit itself was smaller on that side, and the frontal bone, the ear and the whole side of the face was arrested in its development.

Now, sir, the theoretical explanation I have offered you, associated with the result of Professor Ziem's experiments, I trust will impress you that at all events, although many of these cases may be produced by other causes, the disarrangement of the atmospheric pressure on the nose is capable of producing a very serious effect on the growth of the upper jaw. Perhaps

I ought to corroborate the statements of Professor Ziem by partial experiments under my own observations. They are hardly to be called experiments, but observations, that are of very considerable value. I have two members of my own family, a little boy and a little girl, a nephew and a niece, and these two children I saw myself when quite young with beautifully formed teeth and palates. I have photographs of them with faces as round as the moon. I have also photographs of them at eight years of age, one with an underhung jaw and distorted palate and teeth and with a facial expression completely altered. The little girl—your chairman knows her, because she is indebted to him for many dental services—when quite young had teeth in splendid order and a perfect palate. Now the teeth do not meet in front at all. There is a case in point. That case was not hereditary at all events. There is one case Mr. Morton Smale saw with me, a case of cleft palate. I operated upon this cleft palate and made a very good palate, perfectly flat. Nine years after this the boy developed a large amount of post-nasal growths and polypoid tissue that blocked his nose. After nine years this palate split in front and was pushed up into the nasal cavity. This was a case illustrating the effect of nasal obstruction. Of course, when both sides of the nostril

are blocked up through any cause, the inspiration takes place through the mouth, and the air, passing down in front of the palate, would naturally abstract the air from the post-nasal space and cause a marked negative pressure in the nasal cavity. Under these circumstances then you will have a sufficient force to press up the palate and to press in the walls of the the superior maxillary bone, and compress the turbinal bones almost to the septum. I would point out that in looking into the nose in these cases one finds the turbinal bodies sometimes touching the septum and squeezed up to the mid line. The upper jaw and the cavity of the nose as a respiratory organ is completely placed in abeyance.

I trust my remarks have assisted to some small extent to elucidate this very complex subject.

## Discussion.

Mr. Storer Bennett said with every anxiety to learn as much as was possible on such a subject, he confessed he could not feel that anything had been heard that evening which was at all a rational explanation of the appearance presented by the models passed round by Mr. Mayo Collier. Mr. Collier said that up to the age of 10 the nasal septum of a child would be found perfectly straight, and that after the age of 10 a certain blocking of the nose often occurred which pushed up the septum and deflected it. From that the members were led to gather that the extreme distortion shown by some of the models took place after the age of 10. If, however, Mr. Collier would bear in mind the process of development of the jaws and the eruption of the teeth, he would remember that with the exception of the second molars and possibly the canines, but at any rate the second and third molars, all the teeth were in place before the age of 10. It had never been his fortune to see any case of a child whose jaws were well developed up to the age of 10, the incisors and bicuspids and first molars being erupted in anything like a normal condition, and then subsequently an approach to the distortion produced which was shown by those models. He could not, therefore, accept an explanation such as Mr. Mayo Collier had given. He was unable to follow the reasoning of Mr. Collier of the blocking of the nose on one side causing an increased flow of air on the other side, and the pressure being at all sufficient to distort substances like bone, especially the bone of the upper jaw, supported as it was by the surrounding bones. The only evidence, as far as he gathered, brought forward by Mr. Collier was that if a manometer was put into the blocked side when the patient breathed

it would be seen there was a variation of the pressure of the mercury. That was quite obvious. But to take the number of inspirations and the amount of variation of the manometer with each inspiration, and to multiply that by the number of inspirations in every twenty-four hours he did not think was a sufficient proof of the amount of distortion of bone likely to be obtained at the end of a day, a year, or five years. For those reasons—and as it appeared to him those were the principal reasons brought forward in support of the argument—he failed to consider that a fair explanation of what took place had been advanced. If Mr. Collier's argument was not justified, he did not think on the other hand he had succeeded in negativing the theory believed by many people—that of heredity. He (Mr. Bennett) was not standing there to support that theory. All he wished to say was, that if one theory was incorrect it afforded no ground for disproving another one.

Mr. F. J. Bennett pointed out that because a condition did not exist at a very early age it was no sign that it was not hereditary. It was known perfectly well that the child might take on the condition of the parent as its age advanced. There were ample examples of the fact of deformity coming from parent to child, and occurring at various periods of life; therefore while the father and mother might have a deformed jaw and the child at the age of 6 or 7 have a very well shaped one, it was no argument that the child at 12, 15 or 20 would not have the same kind of jaw as the parent. Therefore he did not think Mr. Collier had shown that it might not be hereditary. If Mr. Collier's argument were true that the blocking of the nasal cavity upon one side was sufficient, he would ask how it was that its action did not continue throughout the whole of life. It was noticed that the deformity, by the time the wisdom tooth was well into position, as a rule had run through its course and would not increase. How was it, if the nasal cavity continued to be blocked on one side, that the forces resulting from the blocking, which produced the deformity, did not continue to act throughout the whole course of life, and more and more exaggerate as

time went on. The Society had had many papers in which the nasal cavities had been considered to have an effect on the condition under discussion, and it might still, to a great extent, he thought, be considered to be under a certain amount of doubt, but the fact undoubtedly was that children by the time they had grown up had a very great family resemblance which might fairly be put down to heredity. However obscure and however much it might be a mere name, still it answered the purpose until an actual anatomical explanation was discovered.

On the motion of Mr. Woodhouse, seconded by Mr. Storer Bennett, the time of the meeting was extended in order that the paper might be discussed.

Mr. Keetley could not help feeling the force of the observations made by Mr. Collier and the reasonableness of his hypothesis, but asked him whether the occurrence might not admit of a different explanation. The reason he asked was that one often saw people whose mandibular teeth retreated behind the maxillary teeth in connection with adenoid disease. He remembered when he first came up from the country to London that nothing struck him so much with regard to the physiognomy of the working-classes in London as the extraordinary number of people who had defective maxillæ. He had not the least idea what was the cause of it at that time. Now it was known to be due to the fact that severe post-nasal disease was more common in large cities than it was in some of the bracing country localities. Supposing a case in which there existed for years a general chronic inflammation of the nasal cavities extending right forward as far as the upper lip, that was a case in which one would expect to have hypertrophy of the maxilla, and especially of the middle part of it, simply in connection with the great flux of blood in that region. The chin would appear to retreat. But supposing a case in which there was a nasal obstruction posterior to such obstruction, not attended by chronic inflammation of the anterior parts of the nasal passages, and especially the parts in the neighbourhood of the maxilla and the teeth, then that was a case in which one would

expect atrophy of the nasal region from disuse and prominence of the mandible.

The PRESIDENT could not quite understand Mr. Mayo Collier's remarks with regard to the patient's being underhung. A compact rectangular lower jaw in which the mandibular incisor teeth impinged on to the gum behind the maxillary incisors was usual in these cases. He thought Mr. Collier certainly had in favour of his theory that the cases of V-shaped upper jaw generally occurred with adenoids. As regards the hereditary explanation, he did not think that explained the cause at all, but simply showed that the same cause may be operating in the progeny as in the parent.

Mr. SCHELLING did not know whether one was to understand from Mr. Mayo Collier that the obstruction was generally in both nostrils; otherwise there would be more cases in which the jaw had a good arch on one side and was collapsed on the other.

Mr. W. RUSHTON ventured to think one factor, the tongue, had been overlooked by the reader of the paper. People with occluded nares would keep their mouths open, and the tongue in consequence had not the same chance to exert counter-pressure.

Mr. BAKER asked Mr. Collier whether any cases of obstruction of the nose on one side had made any difference on the internal ear through the difference in pressure on the Eustachian tubes, or whether the pressure was the same on both sides.

Mr. E. G. BETTS thought the members must all recognise one thing about the V-shaped jaws—how very short the molars were. They were short not only in the maxilla, but in the mandible. That was one of the difficulties which had to be got over in fixing a plate.

Mr. MAYO COLLIER having briefly replied,

The PRESIDENT, in the name of the Society, having thanked Mr. Keetley and Mr. Mayo Collier for their valuable papers and the gentlemen who had taken part in the discussion, adjourned the Society to the first Monday in June.

# Odontological Society of Great Britain.

## ANNUAL MEETING,

*June* 5, 1899.

MR. JOHN FAIRBANK,

PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last meeting, which were confirmed.

### ELECTION OF OFFICERS.

The following members recommended by the present Council as officers and councillors for the year 1899-1900 were balloted for and unanimously elected:—President, STORER BENNETT; Vice-Presidents, C. WEST, W. A. MAGGS, and ARTHUR S. UNDERWOOD (resident); W. A. HUNT (Yeovil), HENRY J. WHATFORD (Eastbourne) and G. BRUNTON (Leeds) (non-resident); W. H. WOODRUFF (Treasurer); H. BALDWIN (Librarian); STORER BENNETT (Curator); J. F. COLYER (Editor of TRANSACTIONS). Hon. Secretaries: J. H. MUMMERY (Foreign), H. LLOYD WILLIAMS (Council) and C. F. RILOT (Society). Councillors (resident): J. H. BADCOCK, G. W. BATEMAN, LEONARD MATHESON, E. LLOYD-WILLIAMS, W. J. ENGLAND, J. O. BUTCHER, ARTHUR HOPEWELL SMITH, J. H. REINHARDT, and H. G. READ. Non-resident: A. A. MATTHEWS (Bradford), MORGAN HUGHES (Croydon), J. A. FOTHERGILL (Darlington), WALTER HARRISON (Brighton), ALEXANDER KIRBY (Bedford), MARTIN HENRY (Folkestone), W. H. BREWARD

Neale (Birmingham), D. Corbett, Jun. (Dublin), and Rees Price (Glasgow).

Messrs. May and Northcroft acted as scrutineers.

On the motion of the President, Mr. G. Northcroft and Mr. W. J. May were elected auditors for the ensuing year.

Mr. Keall signed the Obligation Book, and was formally admitted a member of the Society.

The Hon. Librarian (Mr. H. Baldwin) then presented his Annual Report. He said the library continued to be open on Monday and Friday evenings from 6.45 to 8.45, when the sub-librarian was in constant attendance. The number of members who had used the library during the past year (to May 31) had been fifty-two and of visitors sixteen. The number of books borrowed fifty-six. The year's scientific journals have been bound up as usual. The journals exchanged for the Society's Transactions, those purchased and those sent gratuitously, remained the same as in last year, a complete list of which would be found on pp. 150 and 151 in last year's Transactions.

The books which members and friends had kindly presented had been announced in the usual monthly reports. The catalogue was unfortunately out of print, but it had been decided not to compile a fresh one until the Society had entered its new quarters, when an entirely new arrangement of the books might be necessary.

Members were cordially invited to present works to the library which would make the already fine collection more interesting and more complete ; especially authors were invited to present new editions of their works as they were brought out. Members were reminded that a large quantity of odd numbers, also of bound and unbound volumes of the Transactions, were on sale at the following prices: to members bound volumes at 5s., unbound volumes at 3s., odd numbers at 6d.; to non-members at 10s., 8s., and 1s. respectively. The members were also reminded that a suggestion book was kept in the

library, in which the names of any books recommended could be written.

The Curator (Mr. Storer Bennett) reported that Mr. William May had presented some early specimens of attempts at the manufacture of porcelain teeth, made by a French dentist somewhere about the year 1830. He also showed, on behalf of Mr. Parsons, two models of the mouth of a child, aged $7\frac{1}{2}$, who had measles at the age of 4, and it was seen that the crown of one upper bicuspid, which had only developed as far as its neck, was now protruding through the gum, evidently being exfoliated. It was interesting, as it showed that when the time of eruption was approaching, the tooth was being thrown off by nature as valueless, the pulp being dead and therefore incapable of producing a root.

With regard to the year's work in connection with the Museum, Mr. Bennett reported that twenty-four specimens had been presented. That of course was not a very large number, but many were exceptionally valuable, and although any specimens were always welcome, the more rare they were and the more interesting, the greater the value they possessed. He strongly urged members not to look upon common, every-day cases as being valueless, because they were often exceedingly useful as a means of comparison. Curiously enough, the people who visited the Museum seemed to be in the inverse order to those who visited the Library. There were twenty-four members who visited it during the year and forty-three visitors, visitors evidently being rather more appreciative of the merits of the collection than the members of the Society, or perhaps it might be that the members of the Society were already so thoroughly familar with everything in the Museum that they did not find it necessary again to visit it. As heretofore, Mr. Bennett had placed on the table the specimens presented during the last twelve months. On former occasions he had sometimes made appeals to the members which he was very gratified to say had been responded to very warmly by the members of the Society, and that

evening he asked for contributions of specimens of erosion, either that rare form where the enamel looked as though it had just been picked out with the finger-nail, the saucer-shaped depression, or the more common V-shaped depression.

## Casual Communications.

Mr. Bartlett exhibited an interesting denture showing the result of manipulations by the patient. He said that about fourteen years ago a tall, fine, handsome military man came to him to ask him to fit a denture. The man had a very large hole in his palate, the result of syphilis extending into the antrum. The syphilis was contracted in New York, and while he was in the second stage he had a bad toothache, and went to a dentist who removed a tooth. Extensive necrosis ensued, with the result that the antrum was opened. The disease being cured, he came six years later to Mr. Bartlett, who inserted an upper denture, making a projection of rubber which fitted loosely into the cavity, and coating it with Truman's gutta percha. It fitted admirably, and the man went away. About four years afterwards he wrote that the piece was getting slightly loose, but Mr. Bartlett did not see him until last year, when he came and said that he could not get the denture out. He had tried to get it removed by a dentist in New York. Mr. Bartlett looked at the denture and found that it was not as he put it in, and the patient told him that when it got loose, he manipulated it himself, adding little bits of gutta percha heated by the spirit lamp and pushing them up. When it got loose again he followed the same course, and the consequence was that the denture grew until, when he came to Mr. Bartlett, there was a thickness of nearly a quarter of an inch in the centre line between his palate and the plate. Mr. Bartlett managed to remove the denture, which he exhibited. Another denture was made, but not on the same plan. When he took the denture out he expected to see a very bad state of the antrum and the nasal passages, but they were perfectly healthy, and showed no sign of having had anything in

contact, or of food getting in and causing irritation. He presented the specimens to the museum.

Mr. Albert said Mr. Bartlett had not mentioned how long after the contraction of syphilis the tooth was removed.

Mr. Bartlett said about two or three months afterwards.

Mr. Humby said that one of the most remarkable specimens of this deformity was in St. Bartholomew's Hospital. A simple perforation in the hard palate was closed by means of a small cork. The patient found the cork was a little loose and wound a piece of wash-leather round it. The hole commenced slightly to increase, and required more and more wash-leather, until at the time of death the patient had a brewer's bung in the hole, a bung from a barrel, at least $1\frac{3}{4}$ or 2 inches in diameter, wound round with wash leather to close the hole. That proved clearly the extreme risk not of putting anything into a cavity, but submitting the edges of any cavity to pressure.

The President thought the same sort of thing might actually happen to the alveolar ridge. He remembered the case of a lady who was wearing upper and lower dentures. She considered that they were not sufficiently deep, and arranged, in a very clever way, cotton-wool under both dentures; the enormous mass of cotton-wool that she used for the lower plate was amazing. The alveolar ridge entirely disappeared. The lower denture he made for her must have been more than an inch in depth, from the cutting edge of the teeth to the portion of the plate resting on the gum.

Mr. Read said the specimen now in St. Bartholomew's Hospital Museum was that of a woman, and the only assumption was that the bung which was found there enlarged the opening. He had seen one or two other cases. He thought it was a good practice to cover the opening rather early because it protected it from the passage of food and protected the palate.

Mr. Bartlett, replying to Mr. Albert, said the denture

was not made until seven years after the patient contracted syphilis.

Mr. Preedy showed certain improvements in connection with a dental chair. The chair was an ordinary Ellis No. 2 hydraulic chair, only the back part and head rest were united in one piece. The chief advantage was the ease and rapidity with which it could be lowered or raised to adapt itself to any patient. In the case of a very small child a cushion was necessary, and for very tall people the back was raised and a cushion was arranged so as to compel the patient to sit well forward, thus lengthening the back of the chair. Another advantage was the support which the operator had by means of resting his arm against the broad flat surface of the top, and the chair had also the advantage of greatly increasing the comfort of the patient.

Mr. Robbins said he had used the chair for over six months and was extremely gratified with it. He thought it was the most comfortable chair he knew of from a patient's point of view, and nearly so from the operator's point of view. The only criticism he had to make was that it was slightly too wide and the back a little too free in movement.

Mr. West asked if there were any arrangement for horizontal movement.

Mr. Preedy admitted that the weak point of the chair was the clamping arrangement behind. The chair would easily go into a horizontal position.

Mr. Albert showed a modification of Mason's gag, which he had found very useful.

## *Micro-organisms in Dental Caries.*

By Kenneth W. Goadby, L.D.S.Eng.

The question of dental caries involves many issues, and more particularly those relative to the ætiology of the process; it cannot be placed in the same category as those diseases which modern research has shown are due to specific micro-organisms; there is no specific organism of dental decay. That the destruction of tooth tissue is due to the activity of bacteria has been placed on a scientific basis by the researches of Miller, whose admirable pioneer work is so well known to all, but at the same time, although fully appreciating Miller's work, we must refrain from considering it as final. From its very nature, and the wide field involved, the work is of necessity but pioneer.

The results, admirable as far as they go, were obtained with impure cultivations, thereby introducing one of the greatest sources of error with which bacteriological work is beset.

Under these circumstances it is of great impor-

tance to bring into focus the many side issues connected with the problem, and to determine, not the specific organism, but the classes of organisms, their biological, biochemical and other characters, before we can make any further progress in the true study of dental caries.

In examining the biological characteristics of organisms which are to be found in caries, and studying their various reactions, I find that the bacteria present in tooth decay fall into three groups:

(*a*) Bacteria which produce acid.

(*b*) Bacteria which liquefy blood serum.

(*c*) Bacteria which produce pigmentation.

The solution of the lime salts of the tooth is brought about by the acid-forming organisms, which in all cases are the prime movers in the process. The lime salts being removed, the liquefying organisms are enabled to digest the matrix of the dentine, whilst, *pari passu*, the pigmentation of the softened tissue takes place.

It follows, therefore, that the chief points to be investigated in the organisms of dental caries are three in number—*acid production*, *liquefaction*, *pigmentation;* and an organism that does not possess either of these qualifications cannot be admitted as a cause of the decay. We are thus enabled to eliminate from the innumerable species that are to be found in the buccal cavity

or in decaying dentine all those that do not bear a distinct relation to the process under consideration, and which, although often to be found in conjunction with those causing the disintegration of tooth substance, are only adventitious. The acid-forming organisms naturally deserve the first consideration. We must, in the first place, guard against the supposition advanced by some, that all organisms are capable of acid production under given favourable conditions, more particularly so as it is a commonplace bacteriological fact that the usual result of the growth of an organism is an *alkaline reaction in the culture medium*, and that certain organisms only are enabled to reverse this condition, and to produce an acid reaction counterbalancing the usual alkaline condition. Further, some organisms, many of them well-known species, produce a very large amount of alkalinity even in media containing sugar; one organism in particular that I have isolated from the mouth on many occasions does this, a point of much importance in relation to earlier work on dental caries; the cultures used being impure and the one class of organisms neutralising the products of the other, a very eloquent argument for the use of pure cultivations to which the pioneers in the field appear to have been deaf.

I have not considered it necessary to repeat

Miller's experiments upon the action of acid-forming organisms at present, but I think it necessary to note some of the more commonly occurring organisms whose acid production is an established fact, bacteria whose constant occurrence in dental caries cannot be looked upon as merely accidental.

In June, 1896, Dr. Washbourn and myself read a paper before this Society, in which we laid especial stress upon the presence of streptococci in all healthy and unhealthy mouths we had examined, and we also called attention to the rapid acid production by that organism, *i.e.*, Strep. brevis of Von Linglesheim.

I am able to entirely confirm the statements we made then, and I think there is sufficient evidence to place this streptococcus as the most frequently present of all mouth bacteria, as I have obtained it in every one of 500 mouths examined, as well as in 20 cases of dental caries, both on the surface and in the deeper layers when decalcification was progressing.

I must point out at this stage of our enquiry that the question of examination of superficial and deep layers is of first importance; and I have found, in all cases examined, that by far the larger quantity and species of organisms are to be found in the superficial layers, a fact naturally contingent upon the general bacterial conditions

of the mouth. The method adopted for obtaining cultures from the deep layers was similar to that used in making cultivations from the bodies of infected animals.

Extracted teeth were used in all cases to minimise the difficulty of sterilisation, red-hot instruments being the only reliable method. Thus:

(1) The tooth was taken to the laboratory immediately after extraction and the superficial layers of decayed dentine seared with a hot instrument.

(2) The surface was next removed with a sterilised instrument and the fresh surface again seared.

(3) Another layer was then removed and cultivations made as well as coverslip preparations.

By this procedure surface contamination is avoided, and the organisms isolated are those that occupy the van of dental decay in the deep layers.

So far I have only isolated from these deep layers two organisms which occur either together or singly in every case.

The one is the Streptococcus brevis alluded to above, and which, as already stated, produces considerable quantities of acid and which grows with great rapidity upon media containing starch and sugar.

The second of the two organisms is a bacillus quite new to me and which I have been unable to identify with any other organism, and for which I have suggested the name *B. necrodentalis*.

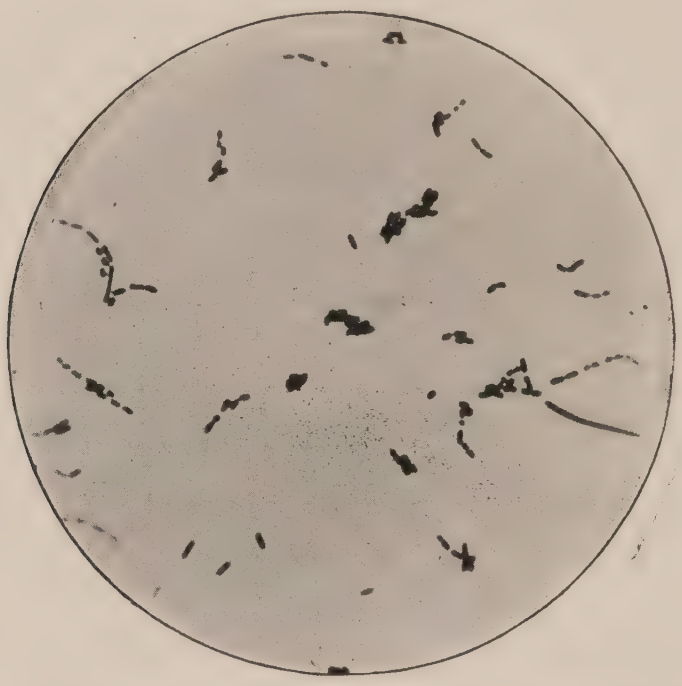

Fig. 1.—*B. Necrodentalis* (48 hours' agar culture, stained Gram); showing pleomorphism. × 1,000.

It is an anærobic facultative, ærobic bacillus and a quick producer of acid. Like most mouth bacteria, it is very pleomorphic, as will be seen from the photo. I have elsewhere[1] described its biological and other characters, so that we may pass on without further reference.

These two organisms, then, *are acid producers*,

[1] "Micro-organisms in Dental Caries," British Dental Association (Ipswich), 1899.

*are capable of anærobic existence, and were obtained from the layers of dentine after the softened parts had been removed, i.e.*, the layers often left in excavating a cavity.

Up to the present these two organisms are the only ones found in the deep layers which are acid producers, but are by no means the only ones to be found upon or near the surface of softened dentine.

Arkövy, of Buda Pesth, published in the *Vierteljahrsschrift für Zahnheilkunde* (xiv. *Jahrgang*, *Heft* iii.) an interesting paper upon Chronic Alveolar Abscess and its Bacteriology. He has found in all cases a bacillus which also appears to be the cause of gangrene of the pulp, and has named the organism B. gangrænæ pulpæ. This bacillus he has also found in decayed dentine, but does not say if in the depths or towards the surface. It liquefies blood serum and gelatine, and is facultative anærobic, but it does not produce acid.

So far I have unfortunately failed to obtain a cultivation of this organism from dentine.

Arkövy also gives a list of organisms found in dental caries which is most confusing, as the organism placed second on the list is of extreme rarity in the mouth (*B. pyocyaneus*), whilst the organism *placed eighth* is one which has only been found once in the mouth by Dobrzyniecki

(see *Centrablatt für Bak.*, Band xxi., 1897). Such a list is of small value, for reasons already pointed out.

A list more to our purpose is one of the acid-forming organisms which are found in dental caries, and in order of their average frequency.

Arkövy's list does not assist us here, as it is relative to the frequency of organisms in alveolar abscess, not in dental caries.

Miller's meagre biological characteristics leave us quite in the dark as to most of the organisms isolated.

One of these, *Micrococcus nexifer*, is without doubt the ordinary mouth streptococcus (*S. brevis*).

Another, as Miller points out, probably *V. Finkler Prior.*

A third, Bacillus ϵ of Miller, I have not as yet observed.

Vignal and Galippe described six varieties of organisms from decayed teeth (*L'Odontologie*, Mars, 1889), acid production not referred to. One of these organisms, a coccus, is probably Sarcina alba.

Vignal's researches deal more with mouth bacteria than with dental decay. He places the two Staphylococci (aureus and albus) last on the list in point of frequency.

Black claims to have found *staphylococci much*

*more* frequently, also micrococcus continuosus (Streptococcus brevis).

Netter only found *Stap. pyog. aureus* in 7 cases out of 127.

Biondi describes a staphylococcus, *Staphylococcus salivarus pyogenes*, which resembles the *S. aureus* in many ways, but certainly differs from it in many respects.

I have found a staphylococcus closely resembling that described by Biondi in many mouths, and I am of opinion that it is this organism many observers have classed as the S. py. aureus.

The following list gives the organisms whose *acid production* is known or has been demonstrated, which occur with tolerable frequency in dental caries. Those whose occurrence is rare or infrequent have been omitted:

*A.—Acid-producing Bacteria in Dental Caries.*

(1) Streptococcus brevis
(2) B. Necrodentalis
} from the deeper layers.

(1) Streptococcus brevis, synonyms M. continuosus (Black); M. nexifer (Miller)
(2) Sarcina alba (? S. alba of Eisenberg)
(3) Sarcinæ lutea, Staphylococcus albus
(4) Sarcina aurantiaca
(5) Staphylococcus pyogenes aureus
,, ,, salivarius (Biondi)
} Superficial layers.

I have isolated a good many other acid-forming organisms which occur occasionally, but have not yet fully examined them all.

The second division of the subject, *i.e.*, the *liquefying organisms found in dental caries*, is of considerable importance.

"Liquefaction foci" are figured by Miller having various forms, but no direct experiments were made to produce artificial liquefaction.

Vignal, who went a step further, tested the action of various mouth bacteria, and says of the species he isolated, "*ten dissolved fibrin, an dnine dissolved albumin.*"

In a recent paper[1] I gave the result of some digestion experiments conducted with organisms isolated from dental caries, and I have shown conclusively that the fact of an organism liquefying gelatin *is no criterion of its power of liquefying decalcified dentine.*

Since reading that paper I have made some further experiments with liquefying organisms, and am able to confirm the statements made, *i.e.*, that the organisms which are able to digest dentine are liquefiers of blood serum, and that, so far as I have tried, those that liquefied ordinary nutrient gelatine only do not affect dentine.

No digestion of normal hard dentine has so far been effected, the tissue always requiring

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[1] "Micro-organisms in Dental Caries," Brit. Den. Ass., Ipswich, 1899.

softening by acids before the digestive enzymes can attack it. In all cases of digestion of dentine the reaction of the medium was distinctly alkaline.

This gives no ground, however, for the supposition recently advanced by Dr. Hunter, who quotes Arkövy, that the process of dental caries might be caused by *non-acid-producing bacteria*, all experiments proving that decalcification precedes liquefaction or digestion.

To complete the second division of our enquiry we must therefore note the organisms found in decaying teeth, and which are capable of liquefying blood serum, which we may take as probable evidence of digestion of dentine from the experiments quoted.

*B.—Bacteria in Dental Caries which Liquefy Blood Serum.*

(1) B. mesentericus ruber, ,, ,, vulgatus } liquefy blood serum.
,, ,, fuscus } liquefy blood serum and dentine.
(2) B. furvus (Goadby)
(3) Yellow bacillus (Goadby). Probably B. gingivæ pyogenes of Miller. Pathogenesis not determined (liquefy blood serum and dentine).
(4) B. fluorescens liquifasciens motilis.

Many other organisms are also found which liquefy gelatin but do not affect blood serum or decalcified dentine.

The "Yellow Bacillus" in the above list is one I have obtained from five cases of caries in mouths which were affected with gingivitis

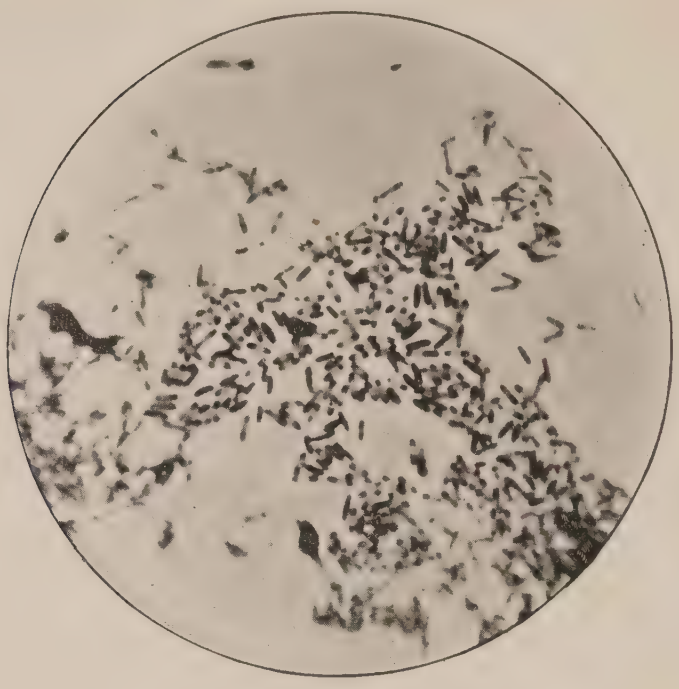

FIG. 2.—*B. Furvus* (24 hours' agar cultivation, stained MacConkey's capsule stain). × 1,000.

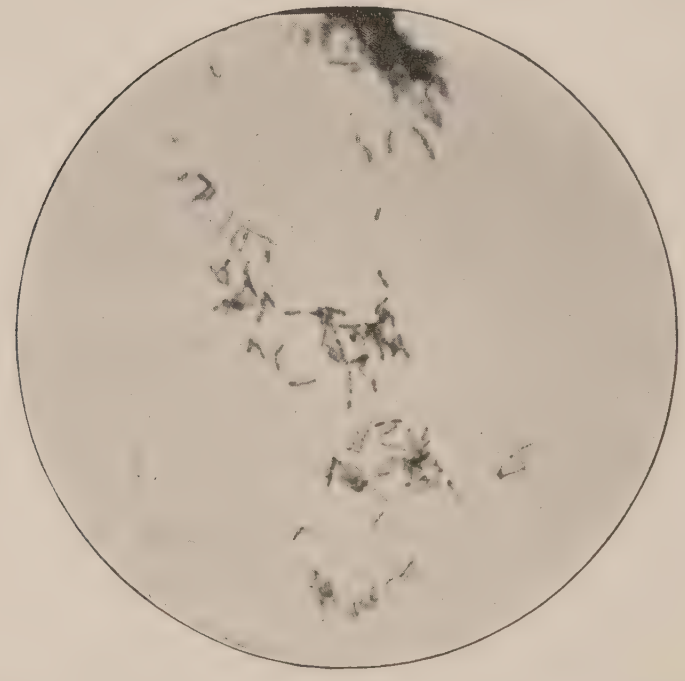

FIG. 3.—*B.* "400." Gelatin culture, 3 days. × 1,000.

marginalis and in which almost all the teeth were carious.

It appears to coincide with Miller's B. gingivæ pyogenes, as far as one can judge from the slender evidence given by that observer *of the growth in gelatin and agar alone*, without staining reactions, motility, &c., &c.

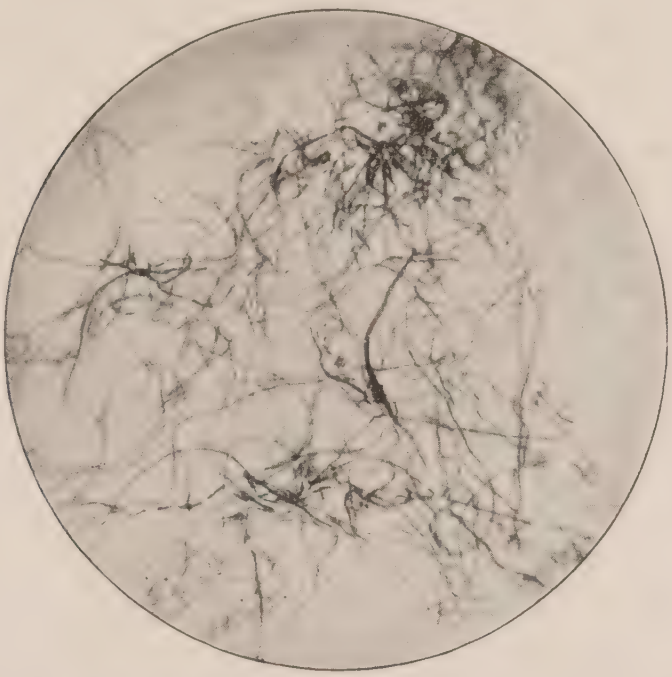

FIG. 4.—*B.* "400" (48 hours' cultivation on slice of decalcified dentine); showing remarkable change in morphology. × 1,000.

However, to avoid confusion I adopt provisionally Miller's term, and append the proper bacteriological characters.

### B. GINGIVÆ PYOGENES.

Found in unhealthy mouths along the gingival margins, in dental caries in such mouths, and in alveolar abscesses.

*Morphology.*—Bacilli from 2 to 6 $\mu$ or more long, often jointed in pairs, and at times curved. Ends square or rounded, ·5 to ·75 $\mu$ wide. Two or three bacilli often lie side by side somewhat in the manner of the Klebs-Löffler bacilli.

Involution forms are fairly common on old cultivations, the bacilli becoming swollen or contorted. Stains by Gram's method.

*Biological Characters.*—An ærobic, facultative anærobic, motile liquefying, chromogenic bacillus. Forms spores which resist a temperature of 75° C. for half-an-hour.

Grows in usual culture media temperature, best at 35° C.

*Growth on Gelatin.*—Plates. Forty-eight hours, irregular wavy, feathery edged colony not unlike B. coli, but with yellow centre lying above the outer paler collarette of pale grey.

In three to four days the colonies liquefy the gelatin, and float on the surface of liquid gelatin in round, crinkled, disc-shaped masses with thickened centre and wrinkled surface, the centre being now yellow-brown. The gelatin becomes of a dark brown colour.

*Gelatin Stab* (20° C.). — Forty-eight hours' growth to bottom of stab; three days, slight cup-shaped, liquefied cavity which gradually approaches the sides of the tube. In newly isolated cultures the liquefaction is somewhat slower and the cone may remain empty.

*Gelatin Shake* (20° C.). — Cloud of minute colonies in forty-eight hours, liquefaction of surface in three days, none in depths.

*Gelatin Streak* (20° C.).—Forty-eight hours, slight liquefied groove with very little appearance of growth; eventually the liquefied mass becomes full of yellowish-white flocculi, with radiating processes.

*Broth* (35° C.). — Twenty-four hours, faint growth of dotted flocculi in fluid, no general turbidity. Three days, thick granular ppt.

*Agar* (35° C.). — Twenty-four hours, well-defined heavy growth, with tendency to spread at intervals along the streak in club-shaped processes; the central portion of the streak and the clubs is of a buff-yellow, the edges grey-white. In time the agar becomes coloured a brownish tint.

*Blood Serum* (35° C.).—Twenty-four hours, broad, deep groove of liquefaction, with brown discoloration of medium.

*Potato* (35° C.). — Twenty-four hours, well-marked dry yellow-brown growth, granular and glistening; the potato becomes coloured throughout. The yellow colour becomes more marked at a later stage.

*Litmus Milk* (35° C.). — Forty-eight hours, well-marked acidity and coagulation of milk; the lower part is decolorised. Eventually the

clot becomes re-dissolved slightly. No gas production and no smell observed.

We have now the *third and final section of the subject* to discuss. Unfortunately, the subject is much too great to satisfactorily discuss in the few moments at my disposal.

Pigmentation of dentine is of common occurrence and of many shades, but the discoloration most frequently met with is the ordinary brownish or almost black colour assumed in most cases of caries.

B. gangrænæ pulpæ of Arkövy produces a brown discoloration of the medium, even when grown in the hot incubator.

This is important, as most chromogenic organisms produce pigment best at low temperatures when cultivated on artificial media; therefore, in isolating chromogens related to pigmented dentine, the organism in question must be capable of pigmentation in the hot incubator.

Miller mentions an organism which produces a brown discoloration of agar, presumably in the hot incubator. No biological facts are given.

Jung has also described an organism (morphology not stated) which produces coloration of the culture media. It liquefies gelatine rapidly, producing a strongly alkaline reaction.

During my own researches upon the bacteria of the mouth I have met with a considerable number of organisms which colour agar (at 35° C.) varying shades of brown, and it is interesting to note that they are in many cases liquefiers of blood serum.

Among the organisms producing a brown coloration is a member of a species hitherto undescribed in the mouth, *i.e.*, cladothicæ, which I described[1] in my recent paper quoted just now.

There are one or two points of further interest to which I should like to draw attention.

*First, with regard to its pleomorphism*, the accompanying photo shows the curious pleomorphic growth obtained in eight days upon potato. Almost all varieties of organisms are morphologically represented, but they all stain by the Gram method, whereas the mouth spirilla which I described last year to you do *not* stain by Gram's method, whilst the cultural characters are quite different. I make this note of warning to prevent any one having the idea that *the cladothrix elements make up the majority of mouth bacteria, as Vincentini has supposed.*

The pleomorphism and the whole cycle of

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[1] "Micro-organisms in Dental Caries," Brit. Dent. Ass., Ipswich, 1899.

events from the thread forms to the spore-like bodies may be seen on all the media upon which it grows. On milk it forms long chains of bacilli or cocci, and a few branched threads. The best medium, however, is potato.

Much irregularity in staining is observed in old cultures—especially with carbol. meth. blue.

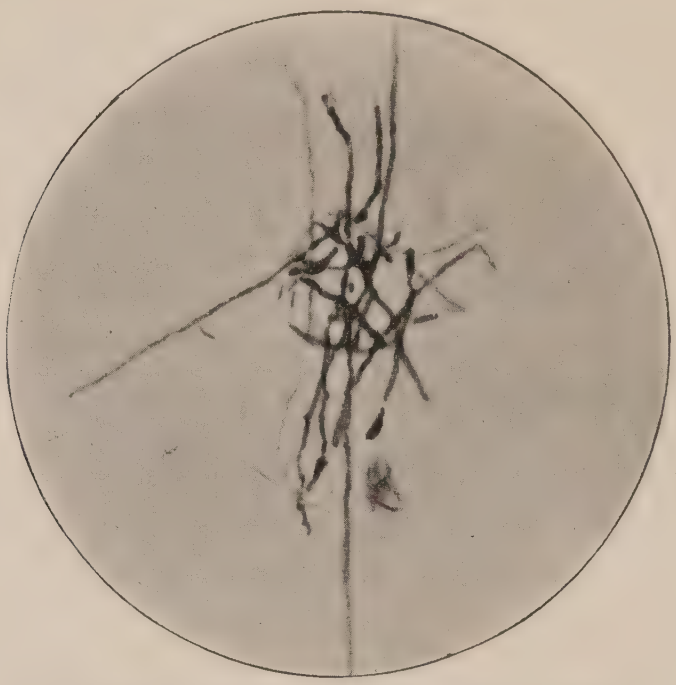

FIG. 5.—*Cladothrix* from mouth direct (stained Gram). × 1,000.

*The second point is the liquefaction of gelatin.*—I have obtained liquefaction of gelatin made with potato water; but on ordinary laboratory gelatin, even when planted from the liquefied potato gelatin, no growth occurs—a curious circumstance I have noted with other mouth organisms.

*The third point is the formation of spores.*—Tested in the usual way, by heating to 75° C. for

FIG. 6.—*Cladothrix* (48 hours cultivation on agar, stained Gram); showing thread forms. × 500.

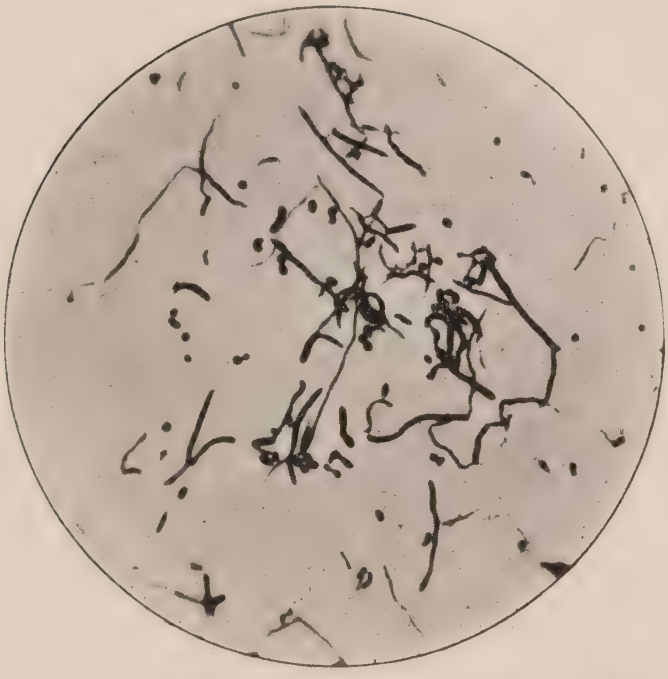

FIG. 7.—*Cladothrix* (8 days' potato culture, stained Gram); showing pleomorphism. × 1,000.

half-an-hour (8-day potato culture) and subsequently making cultivations from the emulsion, no development occurred.

No refractile bodies were observed in the hanging drop.

This organism, then, does not produce true spores.

The following list places in order of frequency the various bacteria of our third subdivision; some of them are new to me, others have been identified with known species.

*C.—Bacteria producing a Brown Discoloration in Dental Caries.*

(1) B. mesentericus ruber.
,, ,, vulgatus.
,, ,, fuscus.
(2) B. fuscus (Miller) ? mesentericus.
(3) B. furvus (Goadby).
(4) "Yellow bacillus" (? B. ging. pyog. Miller).

Several cocci which also produce brown coloration have been noted but are awaiting identification.

In conclusion, I am of opinion that the arguments and experiments adduced prove that the classification of the organisms found in dental caries falls under the three headings I suggest, and that the grouping brings the clinical and bacteriological problems into phase.

And finally, that progress in the subject can only be made if the above system is adopted.

## Discussion.

Dr. Washbourn, in opening the discussion, said he had followed with very great interest Mr. Goadby's work on bacteria of the mouth both in health and in disease. Mr. Goadby had made a very large number of observations upon the bacteria of the mouth, and his paper embodied the main results which he had arrived at with regard to the pathology of dental caries. He thought the members would all agree that it was a very valuable contribution to the subject. The most important point that Mr. Goadby had brought forward was that dental caries was not a specific process but a process somewhat similar to that of putrefaction. It was well known that if animal matter was exposed to the air it underwent putrefaction; its chemical nature undergoing alteration as it split up into simple compounds. That process was carried out by a very large number of different bacteria, which could be divided up into groups. First of all, there was the group of ærobic bacteria, only growing in oxygen, which produced certain changes. Then there was the group of an anærobic bacteria, only growing in the absence of oxygen, and which produced still further and more profound changes than the ærobic ones. Mr. Goadby had pointed out that in dental caries the first process was produced by a group of bacteria which were acid formers, and which decalcified the teeth; and then another group of bacteria came in and broke up the decalcified dentine. Mr. Goadby's method of demonstrating this point seemed to be an exceedingly good one. He took the carious teeth and found that in the van of caries there were groups of bacteria which were acid formers, and then behind those

there were the bacteria which liquefied the dentine. Mr Goadby had pointed out that liquefaction of gelatin was no indicator of the liquefaction of dentine, and that was what one might expect, because it was known that gelatin was very easily liquefied; blood serum was converted with much greater difficulty, and probably decalcified dentine came in between those two in the difficulty with which it was liquefied. A great advantage in Mr. Goadby's work was the fact that he had been dealing with pure cultivations. He had pointed out that a large number of bacteria did not produce acid but alkali. Dr. Washbourn thought, as a matter of fact, that almost all bacteria produced alkali, and that the natural change which bacteria produced in their growth was to form an alkali. All the acid-producers, he thought, failed to produce acid when carbo-hydrates were absent. If the diphtheria bacillus were grown in a medium that produced no carbo-hydrates no acid was produced, but if it were grown in a medium containing carbo-hydrates there was a production both of acid and of alkali, gradually the alkali neutralised the acid and the cultivation became alkaline. This had an important bearing upon the influence of sugar and carbo-hydrates in the production of caries. Mr. Goadby said that the earlier observers were dealing with impure cultivations. Dr. Washbourn did not think these were altogether to be despised, because the more one knew about bacteria the more one felt satisfied that various bacteria worked together and acted in connection. For instance, a pure cultivation of the tetanus bacillus free from toxin injected under the skin of a susceptible animal produced no effect, but if it was injected with some other harmless bacteria, tetanus was produced. Those two bacteria could act together in such a way as to give rise to infection. It was quite possible that similar processes were going on in caries, one bacterium helping the other. He hoped Mr. Goadby would continue his researches, first trying the effect of the acid producers and of the liquefiers, and then finding what result would occur by cultivating the two together. The subject of the formation of pigment by

bacteria was of very great interest. There were certain bacteria that produced pigment which must perform some function. Some people had suggested that the production of pigment was of a protective nature; most bacteria were destroyed by the action of light, and it was supposed that some bacteria were more sensitive to one kind of light than another, which would be shut off by the pigment. If, for example, a bacterium produced a red pigment, the red rays would be absorbed. In the mouth that process could hardly come into play, but there must be some other reason for the production of pigment. He did not know whether he understood Mr. Goadby aright as to the connection between pigment and dental caries. Perhaps Mr. Goadby had ideas and would explain them. He (Dr. Washbourn) had never understood that pigment was really an essential part of the process of caries, and it seemed to him that it was probably only an accident as far, at any rate, as the caries was concerned—that the pigment was a manifestation of one of the functions of the bacteria, and had no actual influence on the production of the disease.

Mr. F. J. Bennett said the members would all feel gratified for the paper Mr. Goadby had read. In respect to Dr. Miller's pioneer work, he was anxious to know whether Mr. Goadby had referred to the first edition, or the edition which had recently been published. In fairness to Dr. Miller, perhaps Mr. Goadby should have consulted the new edition. It would be remembered that when Dr. Miller made his experiments the point which clenched the matter and brought conviction to the minds of most people was that he actually reproduced caries artificially in a way that could not be distinguished from natural caries. It was interesting to enquire whether Mr. Goadby, in the liquefaction specimens which he had made of fragments of dentine, found any of the appearances which were recognised as that of dental caries, such as enlargement and the tobacco-pipe appearance of the tubes, and other conditions. If he had done so, of course that brought the matter very much nearer to the work of Dr. Miller. He did not doubt for an instant that Mr. Goadby had largely advanced the

subject by discovering the three classes of. organisms to which he alluded, but it would be of great interest if he could assure the members that many of the conditions which were found in specimens of true caries were found to obtain also in some of those experiments in which he acted upon decalcified dentine in order to produce liquefaction. It would also be interesting to know whether Mr. Goadby or others had added to their cultivations phosphoric acid, or taken it into consideration. It was known that in the decalcification of dentine and enamel there was an evolution of phosphoric acid, and it was possible that some of the organisms that were found in caries might grow in the presence of phosphoric acid even more freely than without it.

Mr. Schelling asked whether in the specimens Mr. Goadby had examined he had found a green stain on the top, and a slight roughness underneath—whether any special bacteria caused the green stain.

On the motion of Mr. Northcroft, seconded by Mr. Baldwin, the time of the meeting was extended for half an hour to allow of the discussion of Mr. Goadby's paper.

Mr. Storer Bennett said that the paper, following, as it did, a number of others on somewhat similar lines, reminded him of a most interesting series which were given some years ago by Mr. Bland Sutton, treating to a large extent of quite new subjects. When listened to, one seemed to follow the whole story from beginning to end with the greatest ease, and to be able to get up and criticise it, but when this was attempted one came to the conclusion that one had better say as little about the subject as possible until the paper had been published. Mr. Goadby, like Mr. Bland Sutton, was so sure of the facts that he brought forward that one always felt the greatest diffidence in attempting to criticise anything he might say. Several points had struck him, only one or two of which he would inflict on the members. Firstly, Mr. Goadby's classification of the three kinds of bacteria, if correct, was extremely valuable, though the third one, that of the class producing pigmentation, he would venture

to point out could only be affecting the surface of caries, the surface of disintegration, because it was known from clinical work that as soon as a cavity was excavated the black or brown colour disappeared, and a stratum was reached of an entirely different colour. Therefore, he questioned whether Dr. Miller's original suggestion might not perhaps be the correct one, that the pigmentation of dentine was the result either of the disintegration of the germs themselves, or the disintegration of food and some of the dentine itself on the surface. Another point that seemed extremely interesting was that of discovering that the organisms which would disintegrate decalcified dentine were those which would liquefy blood serum. If that were a fact, it seemed to be a very easy sort of signpost in examining certain pure cultivations, pointing the way to the bacteria which were likely and those which were unlikely to be capable of dissolving the decalcified dentine. If, by trying to liquefy blood serum, a series of bacteria were found which would liquefy decalcified dentine, certainly substantial progress would have been made. He was sure unintentionally Mr. Goadby rather slurred over some of Dr. Miller's early work when he pointed out that acid-producing bacteria were always found in advance of disintegration. That was very distinctly pointed out by Dr. Miller in his first edition. Finally, Mr. Storer Bennett thought there was something rather depressing in viewing the pleomorphic changes that took place in certain bacteria, because it showed that only those who had a very profound acquaintance with the subject were justified in dabbling in bacteriology at all. It was obvious that the mere recognition of a bacterium, or even one or two changes in a bacterium, did not justify anyone in coming to any conclusion until he had traced out its life history under all sorts of varied conditions. He felt confident that a great number of bacteria that had been described by different observers were simply the same organisms under different aspects. Therefore it behoved all to be most cautious, in attempting to enter on the subject, to verify in every possible way the experiments

they were making before they came to the conclusion they had met with any new organisms whatever.

Mr. Goadby, replying to the various criticisms which had been made upon his paper, thought his position in regard to Dr. Miller's work had been somewhat misunderstood. He had said that he fully appreciated Dr. Miller's pioneer work, and it had been to him the basis upon which he had been working. But what he wished to point out particularly in regard to Dr. Miller's work was that in describing an organism he gave perhaps two or rarely three cultural peculiarities and nothing else; so that Mr. Storer Bennett's remarks were rather contradictory when, on the one hand, he pointed out how very careful one must be in describing a new organism, and on the other, had objected to his (Mr. Goadby's) criticism of Miller's work for describing organisms without adequate bacteriological and biological statistics. He certainly had referred to Dr. Miller's work in all the latest editions he could get, and he found the same want of method running through the whole of them. He had been trying for the last two or three years to emphasise the point which Mr. Storer Bennett had emphasised, viz., to be extremely careful, scrupulously careful, about describing new organisms, without first giving an extended and careful study of all their characters and their growth on the different culture media. To Dr. Washbourn he tendered his very great thanks for his help from the very start of his bacteriological work. Dr. Washbourn had subjected him to a somewhat stiff *régime*. Mr. Storer Bennett seemed a little inclined to doubt that blood serum was liquefied; he (Mr. Goadby) therefore exhibited a liquefied blood serum tube.

Mr. Storer Bennett said he did not doubt Mr. Goadby for one moment.

Mr. Goadby, continuing, said the alkali production referred to by Dr. Washbourn was a very interesting matter, and might have some relation to the way in which dental caries at times stopped spontaneously. With regard to the pigmentation of the dentine, it was a rather curious thing. It was not what one obtained under

ordinary circumstances with ordinary chromogens, viz., the production of a large amount of surface pigment that one could scrape up from the surface of the medium, but more a pigmentation of the nature one got with the *bacillus pyocyaneus*, the blue colour of which always permeated throughout the whole of the medium, while the surface growth was often quite white. It was quite possible to obtain a brown coloration of softened dentine—in fact, it occurred in a soft dentine when using several organisms to test their liquefaction of tooth cartilage. Dr. Washbourn's remarks with regard to the pigmentary process raised a point which was of great interest to all bacteriologists. It was a thing he need not go into very largely now, but he was interested in it, and in dealing with a great many of the problems of pigmentation he had found he could get perfectly colourless varieties of the pigment-producing organism by subjecting them to certain conditions. A French observer found that by growing the bacillus Rouge de Kiel in sunlight or in a hot incubator he produced colourless colonies which remained colourless in subcultures, whereas the control cultures remain pink. Mr. Goadby suggested that the organism was growing at its greatest point of activity in the hot incubator, and one would expect, if the pigment were a body due to excretory activity, to find it in the largest quantities when the organism was grown in the hot incubator. But that was not so. That was why he was rather inclined to Dr. Washbourn's idea that the pigment might have some recondite influence on the growth of the organism—some evolutionary factor, perhaps. As to the reproduction of the liquefaction foci, he had not done that. It was more histological work than bacteriological. The point he wished to emphasise was not whether liquefaction could be got in some very small corners of the dentine, but the broad fact that dentine was liquefied by certain organisms obtained directly from the teeth in which there was soft dentine, and he thought the chain of evidence was about as close as one could hope for in bacteriological work. The question of phosphates was one that had a good deal of reference to all bacteriological work. In some cases they

were precipitated. He did not think the amount of phosphate liberated by the action of organisms on enamel and dentine would be so great as to modify their growth. It might be, but so far in the experiments he had made in using various phosphate salts he had found very little difference, and the Streptococci brevis grew in anything, even in ordinary water. In regard to Mr. Schelling's question as to green stain, he would find in one of the dental journals[1] some lengthy dissertation on green stain in which he had pretty fully determined that the ordinary bacilli, Fluorescens liquefaciens motilis and the Non-fluorescens liquefaciens motilis, which were very common in the mouth, were the two organisms which occurred fairly commonly in green stain. Those bacilli produced their pigment more easily at a lower temperature, and one often found a germ pigment in children who were mouth breathers.

[1] *British Dental Journal*, December, 1897.

# THE PRESIDENT'S VALEDICTORY ADDRESS.

Gentlemen,—It is with mingled feelings of sadness and gratitude that I address you this evening—this last evening on which I shall have the pleasure and the privilege of occupying the presidential chair of this Society.

There is generally a ring of sadness about the last of anything—the last day at school, the last day at college, the last day in an old home. A time has passed which will never return, and a book has been closed never to be reopened.

At the same time I must express a strong feeling of gratitude to one and all for the kindness and support afforded me during my year of office.

I have to thank the Secretaries of the Society for their loyal and valuable assistance, and especially the gentleman on my left, who, as you know, is mainly responsible for the programme at these our monthly meetings.

To the members of the Council, for their useful suggestions and guidance in the council chamber; to the different office-bearers, the Treasurer, the Curator, the Librarian, and the Editor of the Transactions of this Society, I am deeply indebted. I have, also, to thank personally those gentlemen who have come forward with their papers on various subjects, many of which have been of great value, and have evidenced much labour spent in original research and extreme care in their preparation. Also those who by their casual communications have afforded the Society much information and many valuable suggestions, the result of their observations and practical experience. Nor must I forget those members of this Society who have regularly attended the meetings, and by their presence and their remarks have added to the enjoyment of the meetings.

In reviewing the work of the past year, I have first to notice a paper by Mr. Storer Bennett on "Anchylosis of Human Teeth to the Jaws." The paper was illustrated by some most excellent lantern slides, and provoked discussion which was not upon the whole unfavourable to Mr. Bennett's views.

Mr. R. H. Woodhouse at our second meeting brought before the Society a case illustrating "the effect of the passive mode of regulating teeth"—a mode of treatment devised by Mr. Alfred Woodhouse, of great practical importance, and as simple as it is effective.

Mr. F. J. Bennett also read an interesting paper on "Some Old and New Views of Calcification of the Teeth."

At our January meeting, Mr. Badcock, by an interesting case, which he brought before the Society, demonstrated the very close relation which sometimes exists between the roots of the third upper molar and the floor of the antrum, and showed that perforation may sometimes occur as the result of alveolar abscess, or on the extraction of the third upper molar.

In February, Mr. Matheson read a short communication on "Obtundents," and helped still further to establish the reputation of nitrate of silver as the most useful obtundent we possess.

Dr. William Hunter excited great interest amongst the members of the Society by his paper on "The Relation of Dental Diseases to General Diseases," in which he dwelt specially on the possibility of infection from the mouth. He showed that in connection with septic pulps and pyorrhœa alveolaris, &c., there were constantly present the most virulent pyogenic organisms, as the staphylococci and the streptococci, and proved, in a case of gastritis that came under his care, the coexistence of these organisms in the stomach and the mouth. On removing these organisms from the mouth, by the extraction of some pus-bathed roots, he succeeded in effecting the cure of his patient, but not without a relapse occurring, and not without the aid of the strictest dietary and the administration of salicylic acid.

It is therefore possible that the patient might have recovered without the removal of the roots. The paper, however, clearly showed the desirability of the mouth being kept in a perfectly healthy condition.

At our next meeting we had a remarkable paper on "The Histological Study of Dentine," by Mr. F. T. Paul, of Liverpool. Mr. Paul came expressly to London to read this paper, which, in the words of Mr. Tomes, "added to their knowledge a very material number of facts about dentine formation, and confirmed in the main Mr. Mummery's idea, that in dentine formation a prior formation of connective tissue could be traced, and that it was in that connective tissue that the dentine matrix originated."

The paper was illustrated by very charming photographic slides, obtained from the most perfect microscopic sections I have ever seen.

In April Mr. Tomes kindly read a short paper "On Two Teeth which Presented Unusual Diseased Conditions," showing in these two specimens remarkable instances of extensive absorption and equally extensive deposition of secondary bone.

At our last meeting we had a paper on "The Limitation of the Gape and its Surgical Treatment," by Mr. C. B. Keetley, and another one by Mr. Mayo Collier, on "Deformities of the Teeth and Palate due to Nasal Obstruction." This is a most interesting subject to us dental surgeons, and as Mr. Collier's theories as to the cause of the extreme arching of the V-shaped upper jaw were not generally accepted by the meeting, an exhaustive treatment of the subject in a future paper is still open to some member of this Society.

Since I last occupied this chair winter has changed into summer, and one has no longer any fear of shivering draughts pouring down on one's bald pate. The new building of the Dental Hospital of London is slowly rising from the ground, and has, I believe, reached the first floor. I do not know exactly on which floor the Odontological

Society is to be located (should we find a home in the new building, which I hope and believe will be the case). But we cannot hope to meet in such new and more commodious quarters for at least eighteen months.

The question of a higher dental degree, which is occupying some attention in the profession, is not one in which this Society is likely to play any official part. Looking at it from one point of view, it seems most desirable, though the objections to it may prove stronger than any argument that can be adduced in its favour.

The special nature of our work, both in its science and its practice, necessitated a special diploma, and it seems reasonable that those young men who, by their natural abilities and by their hard work, attain a high standard of excellence in their operations, and a profound knowledge of the scientific part of their profession, should have their exceptional powers confirmed by a recognised degree, in addition to the ordinary diploma of L.D.S. and the general surgical and medical diplomas which they may possess.

As to the future, this Society is very fortunate in its President for next year. I have in my mind at this moment the very able manner in which he presided at the last Annual Dinner "to the past and present students of the Dental Hospital of London."

I was very much struck by the remarks he made with reference to the rapid and disastrous decay of teeth in young people. He invited the younger members of the profession to direct their minds and their endeavours to discover the reasons for it and a way of preventing it, and this new treatment for the radical cure and prevention of consumption reminded me of the subject. I am afraid that the treatment for the prevention of caries would entail too much care and attention on the part of us all for it ever to be generally adopted, unless such treatment becomes recognised as necessary to ensure the well-being of the whole individual. And this does not seem impossible, for take this example; as the teeth suffer considerably in phthisical cases, so does the fresh-air treatment have the most beneficial effect in both cases.

I remember Mr. George, a leading American dentist, advocating thirty years ago, as a preventive of caries, the cutting of V-shaped spaces between all the permanent teeth so soon as they were fully erupted, or at any rate, between those teeth in which caries of the proximal surfaces had occurred in the case of either parent. I need hardly say that this treatment, which has very much to be said in its favour, was never generally adopted.

The careful brushing, and the passing of silk between the teeth twice a day, an extremely moderate and simple diet, constant exercise in the open air, the free ventilation of the schoolroom, the avoidance of all nervous excitement and overstrain, are never carried out. Nor would it be likely that we should consent to our young people constantly chewing some slightly medicated, almost insoluble compound, to keep the fluids of the mouth healthy. No, gentlemen, I must follow in your future President's wake, and appeal to you to discover some simpler way out of the difficulty. Then, when the anti-caries lymph is discovered, many of us will have to look for new pastures. We shall no longer be puzzled by children's teeth, or with the teeth of the poor, a subject which ought ere this to have excited more attention than it has hitherto. We find in small villages a parish doctor and a resident nurse, with a salary of £100 a year, but no provision whatever for the dental needs of the population.

We endeavour here in London to do what we can at our dental hospitals, and at one or two general hospitals, for the preservation and the replacing of the teeth of the poor; but how inadequate our efforts, and how a hundredfold more inadequate, is the support we derive from the general public.

Gentlemen, I have, I fear, taken up too much of your time with my poor remarks, and I bid you farewell.

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Mr. Hutchinson, in proposing that the thanks of the Society be accorded to the President for his services during the past year, and to the officers of the Association for the way in which they had carried out their duties, said Mr.

Fairbank had worthily maintained the traditions of the Odontological Society in the way he had carried out his important duties. He was sure the members would feel very glad that the Honorary Curator had consented to continue in his office, combining it with the Presidentship of the Society. To the Honorary Secretaries, the Treasurer, the Editor of the TRANSACTIONS, and the Honorary Librarian, the thanks of the members were especially due for the constant efforts they made to maintain the traditions of the Society.

Mr. WOODHOUSE, as an old office bearer, appreciated the work which had been done during the past year, and seconded the resolution, which was carried with acclamation.

The PRESIDENT and the HONORARY SECRETARY (Mr. Butcher) briefly thanked the members for the cordial vote of thanks which had been given to them, and the Session closed.

# INDEX.

# ODONTOLOGICAL SOCIETY OF GREAT BRITAIN.

## FORM OF APPLICATION FOR ADMISSION OF MEMBERS.

NOTE.—According to Bye-Law V., this form must be signed by four Members, two at least from personal knowledge for the recommendation of a Resident Member; and by three Members, one at least from personal knowledge, for the recommendation of a Non-Resident Member.

*Name* _____

*Place of Residence* _____

*Professional Qualification* _____

_____

_____

being desirous of becoming a Member of the ODONTOLOGICAL SOCIETY OF GREAT BRITAIN, we, the undersigned, recommend him as well qualified to promote the objects of the Society.

| *From Personal Knowledge.* | *From General Knowledge.* |
|---|---|
| | |

1. Submitted to Council _____
2. { Approved by Council / Proposed to Society } _____
3. Suspended _____
4. Elected _____

**TO THE BINDER.**—This Form is to be bound in at end of Volume.